Forest Service

Forest Pest Management

Davis, CA

NATIONAL STEERING COMMITTEES FOR AERIAL APPLICATION OF PESTICIDES

REPORT NO. 3

FPM 91-3
February 1991

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FEBRUARY 1991

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SECTION 1

THIRD REPORT

National Steering Committee for Application of Pesticides - Gypsy Moth and Other Eastern Defoliators

February 11, 1991

USDA Forest Service
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CONTENTS

I. INTRODUCTION

The meeting was held at the Hilton Inn, Salt Lake City, Utah, on November 7, 1990.

A. Committee Members

J. Robert Bridges	WO/FIDR (Washington, DC)
Leo Cadogen	FPMI (Sault Ste. Marie, Ontario)
Tony Chiotakis	North Carolina Department of Agriculture (Raleigh, NC)
John Cunningham	FPMI (Sault Ste. Marie, Ontario)
Harold Flake	R-8/FPM (Atlanta, GA)
Michelle Frank	NA/FPM (Durham, NH)
Don Henry*	California Department of Food & Agriculture (Sacramento, CA)
Win McLane	USDA/APHIS (Otis AFB, MA)
Mike McManus	NE/FIDR (Hamden, CT)
Steve Munson	R-4/FPM (Ogden, UT)
Max Ollieu	R-6/FPM (Portland, OR))
Dick Reardon	NA/FPM/AIPM (Morgantown, WV)
Barry Towers*	PA Bureau of Forestry (Middletown, PA)
Harry O. Yates III	SE/FIDR (Athens, GA)
Jack Barry (Chairperson)	WO/FPM (Davis, CA)

Asterisk (*) indicated committee members who were not at the meeting. Resignations from the committee were Alice Jones and Dan Twardus. New members are J. Robert Bridges and Harry O. Yates. William Buzzard, Pennsylvania, substituted for Barry Towers. Addresses and telephone numbers of committee members are provided in Appendix A.

Others attending the meeting included: Tom Hofacker, Pat Shea, Julie Weatherby, John Neisess, Gary Daterman, Jesus Cota, Iral Ragenovich, and Temple Bowen.

State and individual committee member reports delivered at the meeting and included in Appendix B are as follows:

1. **Leo Cadogen** - A Report to the USFS Joint Meeting of the National Steering Committee for Application of Pesticides - Western Defoliators, Gypsy Moth, and Eastern Defoliators.

2. **John Cunningham** - Application of Disparvirus Against Gypsy Moth in Ontario in 1990.

3. **Tony Chiotakis** - North Carolina Gypsy Moth Program 1990 Operations Summary.

4. **Jessie Rios** (For Don Henry) - California Gypsy Moth Program 1990.

5. **Michelle Frank** - 1990 Green Mountain National Forest Gypsy Moth Suppression Project; and State of Vermont 1990 Cooperative Gypsy Moth Spray Project Defoliation Assessments.

6. **Win McLane** - Report of Laboratory and Field Pesticide Testing Activities - APHIS - S&T.

7. **Steve Munson** - Utah Gypsy Moth Eradication Program 1990 Gypsy Moth Report.

8. **Ladd Livingston** - State of Idaho Summary Report of 1990 Gypsy Moth Eradication and Survey Efforts.

9. **Oregon** - Gypsy Moth Survey and Detection Programs - 1990.

10. **Colorado** - Colorado gypsy moth activities untitled report.

11. **Washington** - 1990 Gypsy Moth Program Summary Report.

12. **Pennsylvania** - Pennsylvania Gypsy Moth Suppression Project 1990.

13. **Dick Reardon** - Summary of AIPM Activities - 1990; and Status of Gypsy Moth NPV, Gypchek, in USA.

B. Purpose of Committee

The purpose of the committee is to review, identify, and recommend needs for field tests, pilot projects, and demonstrations of aerial application of pesticides. Needs include those associated with pesticides, application systems, techniques, and strategies that influence the USDA Forest Service's and State cooperator's ability to use pesticides safely, effectively, and in an economically, and environmentally acceptable manner.

C. Operating Guidelines

The committee expanded its scope to include use of ground application of pesticides to manage gypsy moth and other eastern defoliators. The committee will also serve, at the request of the Director, Forest Pest Management, as a panel to review national technology project proposals that relate to gypsy moth and other eastern defoliators. Proposals for 1992 will be reviewed during the next committee meeting.

II. CURRENT RECOMMENDATIONS

Current recommendations include new recommendations and certain recommendations carried over.

A. Laboratory and/or Investigations

1. **Investigate canopy architecture of eastern deciduous forests (shape, sub-canopies, density, leaf-area index, etc.) for input and enhancement of FSCBG aerial spray model.**

   High - Mike McManus

2. **Investigate enzyme link immunosorbant assay (ELISA) or other techniques for rapid on-site determination of tank mix potency.**

   High - Pat Shea

3. **Develop priority list of wind tunnel tests needed for undiluted formulations of *Bacillus thuringiensis* (B.t.) is determined by State/Federal cooperators. Conduct physical property/wind tunnel tests for priorities 1-10.**

   High - Dick Reardon

4. **Investigate feasibility of using virus to manage pine sawfly.**

   Medium - Michelle Frank

5. **Investigate use and timing of granular verticillium to control pear thrip.**

   Medium - Michelle Frank

6. **Screen tank mixes for effects on automobile paint surfaces.**

   Low - Win McLane

B. Field Tests

1. Conduct field tests of lower doses and lower volume of Dimilin.

    High
    Priority 5 - Win McLane

2. Evaluate utility of FSCBG aerial spray model to predict canopy penetration model by comparing deposition predictions to observed prediction in eastern deciduous canopies.

    High - NEFAAT

3. Evaluate canopy penetration and spray drift of B.t. spray applied to control gypsy moth in western deciduous forests and compare field results to model predictions.

    High - Jack Barry
    Ken Bentson

4. Conduct B.t. efficacy tests and develop guidelines for using hydraulic sprayers to control gypsy moth.

    Medium - NA
    R-8

C. Demonstrations

Demonstrate utility of the gypsy moth phenology computer-base model supported by Omni-Data weather monitoring system to predict application timing.

High - Steve Munson

D. Equipment, Models, and Technology Development

1. Investigate and demonstrate weather monitoring systems to support gypsy moth control projects and plan for personnel training in use of the systems.

    High - Harold Flake

2. Evaluate capability of FSCBG aerial spray model to predict penetration of a B.t. spray into an oak canopy in Western U.S.

    High - Jack Barry
    Bruce Grim

3. Review aircraft guidance and treatment block marking methods and publish a report that outlines equipment, methods, and advantages and disadvantages of each method.

    High - MTDC

4. Conduct airport trails to verify randomly selected AGDISP swath width predictions reported in 1990 FPM Report Swath Width Evaluation. Make AGDISP model runs for additional aircraft.

Low - Harold Flake
Dan Twardus
Dick Reardon

E. Administrative

1. Pesticide tank mix recommendations for 1991 gypsy moth suppression programs are as follows:

Product	BIU/Acre	Volume/Acre	Undiluted
Thuricide 32LV	16	96 - 128 oz.	NO
Thuricide 48LV	16 to 30	"	16 to 30 BIU
SAN 415 (NRD-12)	"	"	"
Dipel 6AF	"	"	"
Dipel 8AF	"	"	"
Foray 48B	"	"	"

Product	AI/Acre	Volume/Acre	Undiluted
Dimilin 25W	0.03 lbs.	96 or 128 oz.	NO

Footnotes:

For diluted B.t. applications apply at 96 or 128 oz./acre.

Undiluted applications should be no less than 40 oz. of B.t. per acre.

For eradication use 2 or more applications of B.t. 5 to 7 days apart.

Stickers can be added to B.t. formulations if added protection is needed. Use 2% by volume or Bond, Plyac or NuFilm 17. Do not use Bond with Foray.

2. Conduct a workshop to develop standard spray aircraft contracting guidelines and specifications for aerial spraying in the East.

High - Dan Twardus
Harold Flake

3. Maintain contact with EPA to encourage more flexibility on registration of minor use and environmentally acceptable pesticides.

High - WO/FPM

4. Establish a gypsy moth pheromone ad hoc committee composed of FS, APHIS, industry, state, and university representatives.

Medium - WO/FPM

5. **Continue to encourage development of working relationship amongst Canadian and U.S. investigators who are pursuing gypsy moth research.**

High - WO/FPM
WO/FIDR
NA/AIPM

6. **Determine if there is a problem as expressed by members of the committee that poor pilot skill and low quality of application is contributing to poor control of gypsy moth. If there is a problem it might involve one or more factors to include contract specifications, unrealistic expectations, poor communications, inadequate quality control and monitoring, weather, treatment timing, untrained contract supervisors, etc.**

High - Dan Twardus

7. **Support applied research on monitoring gypsy moth populations and on timing of treatment.**

High - WO/FIDR
WO/FPM

III. COMMENTS FROM STATE COOPERATORS:

On November 9, 1990 the committee met jointly with APHIS and State Cooperators to brief the group on recommendations of the National Steering Committee. We also solicited comments from the group and received the following:

A. Need information on how much buffer is needed around areas treated with pesticides using ground sprayers.

B. Need an ad hoc groups to deal with gypsy moth issues related to NEPA endangered species and other related issues.

C. Need an agreement amongst public agencies on the issue of carriers in pesticides used for gypsy moth control. The public wants to know what they are and they want safety data information. This is an issue that the ad hoc group could address.

D. Need research on gypsy moth eradication strategies in the West using viruses on low populations.

E. Need to test phenology model and adapt to the West as host types differ.

IV. STATUS OF PREVIOUS RECOMMENDATIONS

Status of 1989 committee recommendations is summarized below.

A. Laboratory

1. Investigate relationship of drop size to drop number, potency and efficacy to control gypsy moth.

   High - NEFATT

   Study completed by John Bryant and Bill Yendol and data available from Mike McManus.

2. Investigate impact of B.t. and Dimilin on non-target organisms through conduct of literature searches, contacts with Forest Pest Management Institute (FPMI), and field studies.

   High - Mike McManus
   Dick Reardon

   Study in progress with report anticipated in 2 years.

3. Develop a plan to characterize B.t. and Dimilin tank mixes for physical properties, atomization, and evaporation.

   High - Jack Barry

   Wind tunnel tests have been conducted at University of California for FORAY 48B, Thuricide, SAN 415, and Dipel 6 and 8L, and data reported in FPM (Davis) Report 90-9 (Table of Contents enclosed as Appendix C). Compendium of Drop Size Spectra Compiled from Wind Tunnel Tests. Dimilin is basically water thus wind tunnel test are not needed. Wind tunnel data are needed for Dipel 6AF and Dipel 8AF. Gary Melchior has been contacted about this need. Bob Ekblad is contracting for evaporation studies; funding however is not available at MTDC or FPM (Davis) to conduct evaporation studies of all tank mixes of interest to gypsy moth managers. Technology project funding has been approved by WO to develop a model that predicts atomization based upon physical properties of the tank mix.

4. Develop a plan to obtain spreadfactors for tank mixes used to control gypsy moth.

   High - Jack Barry

   The U.S. Army, Aberdeen Proving Ground, was contracted to evaluate B.t. spreadfactors on deposit papers. FPM (Davis) Report 90-8, Spectroscopically Derived Spreadfactors for Different Bacillus thuringiensis Insecticidal Formulations on Paper Impaction Cards. The report discusses utility of kromekote

as an impaction surface and provides spreadfactors for Foray 48B and Thuricide 32 LV. Additionally Alam Sundaram and Errol Caldwell (FPMI) have been contacted about doing spreadfactors work for the FS. The latter is still under discussion. The pesticide laboratory at Pennsylvania State University determines spreadfactors for microbials and should be contacted for spreadfactor information. Recommend that industry be encouraged to provide spreadfactors for their products using standarized methodology.

5. Investigate canopy architecture of eastern deciduous forests (shape, sub-canopies, density, leaf-area index, etc.) for input and enhancement of FSCBG aerial spray model.

High - Mike McManus

Dave Miller, University of Connecticut, was contracted to begin this work. Data was reported at the Winnipeg, Canada Symposium on aircraft use in forestry, Oct. 1990. Proposals have been submitted by Dave to expand this work in 1991.

6. Evaluate carriers for Gypchek.

High - Mike McManus
Dick Reardon

Evaluate the Ready To Use (RTU) in the UC Davis wind tunnel during February 1991. Cooperate with FPMI in evaluating other carriers.

7. Develop a process leading to the commercial production of Gypchek.

High - FPM/WO

WO has developed a technology transfer agreement with ESPRO, Inc. for commercial production of Gypchek. This is being coordinated closely with AIPM and NE Station.

8. Investigate the "Henderson" carrier as a suitable, and physically and biologically acceptable carrier for Gypchek and B.t. formulations.

Medium - Win McLane

No advantages observed and Abbott Labs reportedly is not interested in this carrier.

9. Screen tank mixes for effects on automobile paint surfaces.

Low - Win McLane

No work on this. Primary interest is the effects of undiluted materials especially those with oil carriers.

10. Investigate enzyme link immunosorbant assay (ELISA) or other techniques for rapid on-site determination of tank mix potency.

High - Pat Shea

Contact has been made with Bruce Hammock, University of California. He will supply antibodies and might have a graduate student available to develop the process for the FS, Pat Shea also will coordinate with Somu Sundaram, FPMI.

B. Field Tests

1. Conduct field test(s) to compare insect efficacy resulting from applications with rotary and hydraulic atomizers using operational tank mixes of B.t.

High
Priority 1 - NEFATT

Test completed and report in preparation.

2. Conduct field test of Foray 48B comparing efficacy of 12 BIU applied 96 ounces per acre to 36 BIU applied 96 ounces per acre.

High
Priority 2 - Mike McManus

Field test completed in 1989 and results reported.

3. Conduct field test of Gypchek comparing efficacy of standard dose to two lower doses.

High
Priority 3 - Mike McManus

Field test completed and report in preparation.

4. Conduct field test to compare efficacy of an operational tank mix of B.t. tank mix containing the "Henderson" carrier.

High
Priority 4 - Win McLane

No difference observed in field test.

5. Conduct field tests of lower doses and lower volumes of Dimilin.

High
Priority 5 - Win McLane

Field test of 16 oz/acre completed and plan to test lower dosage.

C. Demonstration Projects

1. Demonstrate control strategy of using Gypchek against small (50-75 acre) isolated infestations of gypsy moth.

High - Win McLane

Successfully demonstrated in North Carolina and West Virginia. Reports are pending.

2. Evaluate capability of FSCBG aerial spray model to predict penetration of a B.t. spray into an oak canopy in Western U.S.

High - Jack Barry

Study was conducted by Bruce Grim and Jim Rafferty, U.S. Army, 1990 in conjunction with the R-4 gypsy moth project. Data are being analyzed and report due September 1991. Plan to continue field study in 1991.

3. Demonstrate utility of the gypsy moth phenology computer - bases model supported by Omni-Data weather monitoring system to predict application timing.

High - Steve Munson

Some work has been done but more data is needed. Study will continue in 1991.

D. Pilot Projects

1. Conduct a pilot project to test Foray 48B, 30 BIU, applied undiluted to determine if the application can consistently reduce gypsy moth populations.

High
Priority 1 - AIPM

Pilot project completed and report is pending.

2. Conduct a pilot project to test efficacy under operational conditions Dipel 8AF, 30 BIU, applied undiluted.

High
Priority 2 - AIPM

Pilot project completed and report is pending.

E. Equipment, Models, and Technology Development

1. Investigate both ground and aerial application equipment systems and methods to control hemlock woolly aldegid.

   High - Michelle Frank

   Not done and interest in this insect is waning.

2. Investigate and demonstrate weather monitoring systems to support gypsy moth control projects and plan for personnel training in use of the systems.

   High - Harold Flake

   Equipment has been purchased and some limited operational use. Need to design and conduct a test in cooperation with a State to demonstrate the operational utility and application of the weather monitoring system; and to develop a strategy for its use.

3. Evaluate utility of FSCBG aerial spray model to predict canopy penetration model by comparing deposition predictions to observed prediction in eastern deciduous canopies.

   High - NEFATT

   One study has been completed and preliminary results reported. More work are planned in 1991.

4. Review aircraft guidance and treatment block marking methods and publish a report that outlines equipment, methods, and advantages and disadvantages of each method.

   High - MTDC

   State Cooperators expressed strong interest in this subject. Director, WO/FPM has requested MTDC to develop a proposal on how to obtain this needed information. A proposal is in preparation.

F. Administrative

1. Concurred with recommendation of the western defoliator steering committee to meet jointly in 1990. Harold Flake and Steve Munson agreed to host the meeting to be held in Salt Lake City, UT, November 6-8, 1990.

   Meeting was held in Salt Lake City as recommended and reported herein.

2. Recommend research and development of guidelines on timing of pesticide treatments to control gypsy moth.

   Dick Reardon will coordinate this activity.

3. Recommend that the Dan Twardus gypsy moth monitoring data-base be made available annually to State Cooperators and to this committee.

   Report has been published and is available from Dan Twardus at Morgantown, West Virginia (304) 291-4133.

4. Recommend development and conduct of an east-wide pesticide-use training workshop annually for control of eastern defoliators.

   NEFAAT has sponsored one workshop and has scheduled another.

5. Recommended tank mixes for 1990 suppression.

   This list will be updated annually by the B.t. gypsy moth ad hoc committee. Need recommendations from Win McLane.

V. Summary

The National Steering Committee for Application of Pesticides - Gypsy Moth and Other Eastern Defoliators met in Salt Lake City, Utah, November 7, 1990. The committee reviewed previous committee recommendations and noted numerous field projects have been completed; however reports are not available on the majority. New recommendations were developed and listed with previous recommendations that have not been addressed. The committee decided to include ground application of pesticides to its scope of activities. The committee will review 1992 FPM technology development project proposals for WO/FPM at its next meeting in June or July 1991.

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STATE AND COMMITTEE MEMBER REPORTS

A Report to the USFS Joint Meeting of the National Steering Committee for Application of Pesticides - Western Defoliat~~ions~~ors, Gypsy Moth and Other Eastern Defoliat~~ions~~ors.

Salt Lake City, Utah   6th - 8th November 1990

Compiled by B.L. Cadogan

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Research Activity: Impact and fate of insecticides in the envirolment.

Principal Researchers:

1. K.M.S. Sundaram - Distribution, Deposition and Persistance of Bacillus thuringiensis (kurstaki) [B.t.(k)] in a Deciduous Forest Enviroment.

Undiluted Novo Foray[R] 48B Bacillus thuringiensis (k) formulation was sprayed in May 1990 over four blocks of a deciduous forest with oak stands in the Hawley area of eastern Pennsylvania at two dosage rates in duplicate at 20 BIU/53 US oz per acre (50 BIU/1.57 L per hectare) and 30 BIU/80 US oz per acre (75 BIU/2.37 L per hectare). Prespray and postspray oak foliage and simulated oak foliage samples were collected at intervals of time and stored in alkaline buffer with NaN_3 for assaying the concentration levels of B.t.(k) (60 kilodalton, kDa) toxin. B.t. deposits in ground samplers (glass-fiber discs mounted on collection units and alkaline buffers in petri-dishes) were also collected at 1h postspray. Droplet densities (droplets/cm^2) and droplet size distributions (NMD, VMD, D_{max} and D_{min}) were measured at canopy and ground levels using Ciba-Geigy water sensitive papers (10 mm x 26 mm) mounted or fastened onto supports.

Gypsy moth larvae were bioassayed (force feeding) against the alkaline buffer extract of the formulation (Novo Foray[R] 48B), and a calibration curve (% mortality vs concn. of 60 kDa) was prepared. Pre- and postspray B.t.(k) extracts of simulated and natural oak foliage) were bioassayed and the mortalities of the larvae determined. Using the calibration curve, the concentration of the 60 kDa B.t.(k) in the analytes were established. The concentrations of the 60 kDa B.t.(k) in different extracts were also quantified by using an enzyme-linked immunosorbent assay (ELISA) developed cooperatively by the author and Dr. D.B. Hammock (Univ. Calif., Davis, CA). The ELISA studies are in progress and involve the coating of the microtiter plates successively with goat anti B.t.(k), addition of analyte [B.t.(k) extract], addition of rabbit anti B.t.(k), goat anti-rabbit IgG (enzyme labeled) and developing a yellow color for spectroscopic quantification with the addition of a substrate. Using the bioassay and ELISA data, the distribution and persistence of B.t.(k) as 60 kDa will be evaluated. If efficacy data are made available, attempts will be made to correlate the residue levels with observed larval mortality.

Collaborative Research Areas:

The principal researcher will be pleased to interact with researchers interested in the above areas, viz; B.t. deposit assessment, B.t. quantification via bioassay and ELISA and evaluation of the persistence and fate of B.t. in a forest enviroment.

2. Stephen B. Holmes (Project Leader) and D.P. Kreutzweiser - Effects of B.t. on Non-Target Organisms.

B.t. is the most widely used forest pest control product in Canada. When it was still a minor component of forest spray programs, relatively little attention was paid to the environmental effects of B.t. Concern was focussed more on the chemical insecticides, such as fenitrothion, because these were perceived as being more damaging to the environment. Now, however, because of its increased use, B.t. is being looked at more closely.

At the Forest Pest Management Institute (FPMI), three studies that deal with the environmental impacts of B.t. spraying are underway. Each of these studies is described briefly below:

Toxicity of B.t. to Stream Insects

Relatively little has been published in the scientific literature on the toxicity of B.t.k. (Bacillus thuringiensis kurstaki) to aquatic insects. Eidt (1985) tested 9 taxa of aquatic insects, representing 4 major orders, Trichoptera, Plecoptera, Ephemeroptera and Diptera, for susceptibitliy to B.t. at concentrations of 4.3, 43 and 430 IU/mL under static conditions. The concentrations were chosen to represent a worst-case field situation, a 10X overdose and a 100X overdose, respectively. Only one species of blackfly was clearly affected by the B.t., and this was at the highest concentration. Although effects on other species were suggested, Eidt concluded that the risk to aquatic insects was low and that buffer zones were not required around water bodies for aerial spraying with B.t.k.

There are currently no buffer zones around standing water for aerial spraying with B.t. in Newfoundland, New Brunswick, Quebec and Ontario (Kingsbury and Trial 1987). Nova Scotia requires a 30 m setback for aerial spraying of all pesticides, including B.t. (Kingsbury and Trial 1987).

Recently, concern has been expressed by Environment Canada, Conservation and Protection, in British Columbia that the data base for B.t. is too limited to adequately assess the requirement for buffer zones around fishery sensitive streams. They suggest that further testing is needed, and that, until the information from these tests is available, a buffer zone of 10 m should be imposed.

In order to fill one of the data gaps identified by Environment Canada (i.e. the need for more comprehensive and reliable toxicity data), FPMI is conducting laboratory and field bioassays with B.t. and stream insects. The apparatus used in the laboratory tests is a flow-through design (Rodrigues and Kaushik 1984) that more closely simulates the natural stream environment than the static system of Eidt (1985). The initial test for each species is performed at 100X the expected environmental concentration (EEC) as calculated by the Department of Fisheries and Oceans Canada (i.e. 100 X 6 IU/mL). The total exposure and observation periods are 24 and 216 h, respectively. If a positive response is observed at this concentration, an additional test is conducted to determine the LC50. Field bioassays are performed in artificial stream channels. These tests concentrate on a sublethal response (i.e. induced drift) to the insecticide. The concentrations tested are arrived at in the same way as in the laboratory tests, except that an EC50 is calculated. The exposure and observation periods are 2.5 and 168 h, respectively. To date, 6 species

have been tested using this approach (Heptagenia flavescens, Stenonema sp., Isonychia sp., Isogenoides sp., Acroneuria sp., and Hydropsyche sp.), and no lethal or sublethal effects have been detected at 100X the EEC.

3. Principal Researcher: Kevin Barber - Relative Susceptibility to B.t. of Non-target Lepidoptera Larvae.

According to Dimond and Morris (1984), the larvae of 200 species of Lepidoptera are known to be susceptable to B.t.k. In addition, field studies have shown that B.t. spraying to control forest pests can signfficantly reduce populations of non-target Lepidoptera (Bendell 1986, Miller 1990). Lepidoptera are ecologically important because they function in food webs as herbivores and because they are a food resource for birds and other wildlife (Miller 1990). Lepidoptera are also esthetically valuable to amateur and professional naturalists and entomologists.

Studies at FPMI with B.t. and non-target Lepidoptera have focussed primarily on the caterpillar fauna of blueberry (Vaccinium angustifolium). These caterpillars are an important food resource for grouse, songbirds and small mammals in jack pine plantations. The relationship between B.t. spraying to control jack pine budworm and secondary effects on non-target wildlife was initially explored by J.F. Bendell of the University of Toronto (Bendell 1986, Innes and Bendell 1989), and some field work described below was conducted cooperatively with him.

In 1989, two 80 ha blocks of jack pine forest near Gogama, Ont. were aerially sprayed with B.t. Effects on blueberry leaf-feeding Lepidoptera were assessed in two ways: 1) larval populations were sampled by sweep netting along transects in treated and control areas, before and after spraying; and 2) field bioassays were conducted in which Itame brunneata (Lepidoptera: Geometriadae) larvae, one of the most abundant caterpillar species on blueberry at the time of treatment, were fed blueberry foliage collected from sprayed and unsprayed areas. Preliminary results suggest that caterpillar numbers were reduced on blueberry for up to 15 days after treatment. Results for individual taxa are not yet available. In the bioassays, mortality rates for Itame brunneata were in the range of 28-41%.

In addition to the studies described above, laboratory bioassay protocols are being developed for non-target Lepidoptera larvae. This includes establishment of laboratory cultures of important species. Attempts to rear Itame brunneata have met with only limited success so far. Better progress is being made with some other common species from blueberry (e.g. Orthosia revicta (Lepidoptera: Noctuidae)). In the laboratory bioassays, a number of dosing procedures are being investigated, including direct oral intubation and feeding of contaminated leaf disks and diet plugs.

Principal Researcher: R. Millikin - Secondary Effects of B.t. Spraying on Forest Songbirds.

Lepidoptera larvae are the preferred food for most breeding insectivorous forest birds (MacArthur 1958, Holmes and Schultz 1987), and are important for the growth and survival of the young of omnivorous species (Petersen and Best 1986, Johnson and Boyce 1989). By reducing the availability of caterpillar prey, B.t. spraying could indirectly affect forest birds.

In 1989, a study was conducted to determine the effect of B.t. spraying on the reproductive success of ground-nesting songbirds in jack pine plantations. This study took place in the same blocks as the caterpillar work described above. The methods used included singing-male censuses, observations of foraging behavior and feeding of young, collection of food samples from ligated nestling, determination of nestling growth rates and survival, and mist-netting of banded individuals.

The results are preliminary, but the following general observations can be made. Fewer food items were brought to hermit thrush young in the treated areas than in the control areas (4.8 versus 6.8 items/crop sample, respectively), and Lepidoptera larvae made up a significantly smaller component of the diet of treated nestlings (7% of food items versus 58% in control). These differences in diet did not translate into differences in growth rate or survival of nestlings (the probability of survival in the treated area was 0.40 and in the control was 0.23). The results were generally similar for other ground-nestling bird species (i.e. junco, white-throated sparrow and black and white warbler). Considering ground-nesting birds as a group, there was no significant difference in the proportion of young caught by mist-netting in the treated versus the control areas (21% and 25% of the total catch, respectively), or in the ratio of young to adult females. It is concluded that the observed reduction in caterpillar food resulting from the B.t. spray did not have a significant adverse effect on the growth or survival of young ground-nesting songbirds.

The studies described above are ongoing within the Environmental Impact Project of FPMI. David P. Kreutzweiser is responsible for aquatic toxicology studies, Kevin N. Barber for non-target Lepidoptera bioassays and Rhonda L. Millikin for forest songbird studies.

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Collaborative Research Areas: (Contact the project leader - S. Holmes)

1) Laboratory and field toxicity testing of forestry pesticides (hexazinone, trichlopyr and B.t.) on non-target aquatic invertebrates in flow-through systems.

2) Development of standardized methodologies to test the side-effects of pesticides on beneficial terrestrial arthropods. Establishing laboratory cultures of non-target Lepidoptera and conducting bioassays with B.t. and gypsy moth NPV.

3) Secondary effects of B.t. spraying on forest songbirds.

4) Development of microcosms to study the fate and environmental effects of microbial forest pest control products in the laboratory.

Research Activity: Control of Eastern Defoliations

Principal Researcher: A. Sundaram - Research Studies on Physicochemical Aspects of Pesticide Performance (conducted in 1990).

During 1990, the Pesticide Formulations Project at FPMI undertook two field studies, and two laboratory studies to examine (i) the influence of physicochemical properties of the end-use mixtures on droplet size spectra of the spray cloud, droplet spreading on foliage, and deposits on glass plates; and (ii) the rainfastness of foliar deposits of B.t. and glyphosate formulations.

Field Studies:

Effect of Droplet Size and Cumulative Rainfall on Rainfastness of Foray 48B deposits on balsam fir foliage under field conditions:

A small scale field study was conducted using the single tree treatment technique to determine the rain-fastness of foliar deposits of B.t. as determined by spruce budworm bioassay using 4th instar larvae. Foray 48B was diluted with water and sprayed over balsam fir seedlings (about 1 m high) at a dosage rate of 32 BIU in 4 L per ha, using a spinning disc atomizer, Micron Flak[R], calibrated to gerenate a narrow drop size range with an NMD of 80 um and a VMD of 86 um. Drops were counted on fully flushed needles and drops per sq. cm were evaluated.

Simulated rainfall of two different drop size spectra (almost monosized drops), with VMD values of 250 and 400 um, and two different cumulative rainfalls of 1 and 3 mm, were generated using Micron Herbi[R], and applied onto the seedlings at 24 h after B.t. application. Foliar branch tips containing fully flushed young buds were collected at different intervals of time up to 14 d after B.t. treatment, for bioassay using laboratory reared spruce budworm larvae. Mortality was assessed daily, and body weight depression once in two days, for a period of 14 days after treatment.

A comparative evaluation of the data on post-spray (within 15 min after application) and pre-rain samples (i.e., those collected at 24 h post-treatment) indicated that about 30% of B.t. activity was lost in 24 h after application. B.t. deposits were washed off under both intensities of rainfall, but wash-off was significantly higher at 3 mm than at 1 mm rain. Cumulative rainfall influenced B.t. wash-off from fir foliage much more than the droplet size of rain. Body weights were more depressed and mortality was higher in insects fed with buds collected before the rainfall, than with those collected post-rain. The data will be used to develop a model to understand the inter-relationships between size and impact velocity of rain drops, cumulative rainfall, and B.t. wash-off from balsam fir foliage.

Body weight depression and bioassay results on samples collected up to 14 d after treatment from seedlings that received no rain indicated that initial loss of B.t. activity was rapid within two days after treatment (a loss of about 50% of the deposited amount) but further loss was relatively slow. Measurable but very low B.t. activity still persisted for up to 9 to 10 d after treatment. This was detectable both by body weight depression and by low larval mortality. Further studies are on the way to understand the mechanism of loss of B.t. activity from treated foliage.

Collaborative Research Areas: The principal researcher will be willing to collaborate with USFS researchers in the following areas:

1) Factors contributing to the rainfastness of pesticides (e.g. droplet size and formulation properties)

2) Pesticide mechanisms.

2) Principal Researcher: Leo Cadogan - Efficacy of Dipel 352 (Dipel 16L) against spruce budworm.

A trial was conducted in NW Ontario to determine the efficacy of Dipel 352 (Dipel 16L) against fairly high (25 to 62 larvae/45 cm branch) populations of spruce budworm. The B.t. was sprayed undiluted at 30 BIU/ha (0.9 l/ha) and the budworm responses were examined on black spruce Picea mariana and balsam fir Abies balsamea species with widely different phenological developments.

One treatment matched the development of balsam fir (= peak budworm L_4) and the other block was sprayed 9 days later to match black spruce's development (= peak L_5). Results indicate that when the spray was timed to suit balsam fir development, budworm population reduction was less on both host species than when it was timed to suit black spruce.

In both blocks, defoliation was not different from that in the control. This suggests that these treatments were not effective against high budworm populations in protecting host tree foliage.

Areas of Collaborative Research: The principal researcher would like to collaborate with USFS researchers in the following areas:

1) Experimental design, methods and evaluation of aerial field trials.

2) Spraying and block marking techniques.

3) Responses of defoliations to insecticides.

3) Principal Researchers: Kees van Frankenhuyzen and Vince Nealis

a) Dose acquistion of B.t. by spruce budworm in relation to larval development, foliar deposits and persistence and weather conditions.

b) Foliar persistence of aerially applied B.t. on balsam fir in relation to weather conditions.

c) The influence of B.t. application timing on the survival of some spruce budworm parasitoids.

This research was conducted simultaneously with the efficacy trial. The results are currently being analyzed. Contact Kees van Frankenhuyzen or Vince Nealis for further information.

3) Principal Researcher: B.V. Helson - Insecticide Toxicology

a) New Insecticide Development

We have been assessing the potential of 4 new insecticides for the control of forest defoliators; alpha-terthienyl, RH5992, abamectin and its semi-synthetic derivative, MK-243 in the laboratory. Alpha-terthienyl, a natural phototoxic compound from members of the plant family, Asteraceae, has prevouslyy been tested on spruce budworm, jackpine budworm, eastern hemlock looper, forest tent caterpillar, white-marked tussock moth, and black army cutworm in collaboration with Dr. J.T. Arnason and A. Ceccarelli, U. of Ottawa and Dr. W.J. Kaupp, FP.I. In 1990 alpha-terthienyl was evaluated on gypsy moth larvae, but further tests are needed to confirm its toxicity. To date, all tests have been topical applications followed by exposure to near-UV light. We plan to asses its toxicity to SBL and EHL by ingestion and crawling contact exposure.

RH5992 is a novel insect growth regulating compound discovered by Rohm and Haas and under development bythemm. Dr. A. Retnakaran, FPMI, and I have been evaluating this compound against several forest lepidopteran defoliators. I have examined its toxicity to spruce budworm, eastern hemlock looper and gypsy moth larvae by direct contact and on sprayed foliage as well as its effects on feeding rates. In addition, the effects of exposure period on toxicity and the residual toxicity of RH5992 are being investigated.

Abamectin has been isolated from a soil microorganism, Streptomyces avermitilis by the Merck Sharp and Dohme Research Laboratories and is now registered as an miticide in the USA. MK-243, a semi-synthetic derivative of abamectin, has recently been developed and is reported to have very high activity to Lepidoptera. We have just begun testing MK-243 on SBL and EHL in comparison with abamectin. It appears to be very potent to these pests. We pln to expand our screening program against several other forest pests including gypsy moth.

b) White Pine Weevil

For several years we have been assessing the potential of pyrethroids, particularly permethrin, for the control of WPW adults in the laboratory with encouraging results. In 1990, P. deGroot, FPMI, and I collaborated in conducting a field trial to assess the effectiveness of permethrin in protecting leaders of jackpine from weevil attack. Leaders were sprayed by hand with dosages of 70 and 140 g AI/ha in early spring. Methoxychlor was sprayed at 1 kg/ha as a standard for comparison.

c) Pine False Webworm

In 1990, D.B. Lyons, Forestry Canada, Ontario Region, and I collaborated in laboratory and field trials to develop an insecticide control strategy for the pine false webworm on red pine. Laboratory bioassays with 10 common, rgistered insecticides were carried out with newly hatched larvae on sprayed red pine branches. Field trials were then conducted with Ambush 500EC (permethrin) at 35, 70 and 2 x 35 gAI/ha, and Sevin XLR Plus (carbaryl) at 12, 250, 500 and 2 x 125 gAI/ha applied by mistblower in a red pine plantation.

d) Seedling Debarking Weevil

For the past three years we have been conducting insecticide bioassays with Hylobius congener adults in cooperation with Bruce Pendrel, Foresty Canada, Maritimes Region. The residual effectiveness of permethrin, chlorpyrifos and fenitrothion for protecting conifer seedlings for up to 2 years is being evaluated by spraying or dipping potted white spruce and red pine seedlings with selected concentrations of these insecticides, placing the seedlings outdoors and exposing weevils to them at yearly intervals.

e) Other Pests

We recently completed field trials to determine the efficacy and optimum timing of permethrin for the control of spruce budmoth, Zeiraphera canadensis larvae in cooperation with M. Auger, Quebec Ministry of Energy and Resources. We are currently screening insecticides against Conophthorus cone beetles in collaboration with P. deGroot. We also conducted preliminary insecticide bioassays on black headed budworm, Acleris variana this year.

Collaborative Research Areas: The principal researcher is willing to collaborate in laboratory and field studies relating to these or other promising new products and to the development of insecticide control stratagis for the above pests and others of potential importance in Canada if resources and time permit.

4) Principal Researcher: John C. Cunningham - Virus Application Project

a) Gypsy Moth

Most of the activity of the virus application project has been focussed on gypsy moth for the last 3 years. A registration petition for Disparvirus, the name given to our Canadian product, was submitted in April 1990 and is currently being evaluated. Much of the data in this package were obtained from the Gypchek registration petition.

In 1988, a double application of Disparvirus at 1.25 x 10^{12} PIB/ha (total 10^{12} PIB/ha) in an emitted volume of 10.0 L/ha using an aqueous tank mix gave excellent results when applied on first instar larvae. However, this dosage and emitted volume are both considered to be too high for operational use. In 1989, a double application of 5 x 10^{9} PIB/ha (total 10^{12} PIB/ha) was tested at 10.0 L/ha and 5.0 L/ha on first instar larvae. The aqueous tank mix contained 25% molasses, 10% Orzan LS and 2% Rhoplex B60A sticker. The lower dosage was also deemed to be satisfactory. Hence the recommendation for Disparvirus application was changed to a double application of 5 x 10^{11} PIB/ha in 5.0 L/ha.

In 1990, a further reduction in emitted volume to 2.5 L/ha was tested and compared to 5.0 L/ha using the aqueous tank mix. Results with 2.5 L/ha were not as good as 5.0 L/ha, so a further reduction in emitted volume is not recommended when using this aqueous tank mix. A trial was also conducted during the 1990 season, with Gypchek, which was supplied by USDA Forest Service colleagues. The dosage was a double application of 5 x 10^{11} PIB/ha (total 10^{12} PIB/ha) in 5.0 L/ha using an emulsifiable oil tank mix. Larvae were mainly in the first instar at the time of application. The tank mix contained 25% Dipel 176 blank carrier vehicle and 75% water. Excellent results were obtained and it is suggested that this tank mix and dosage be tested at an emitted volume of 2.5 L/ha.

A commercial source of gypsy moth viral insecticide is vital if it is going to be used operationally in Ontario. FPMI is negotiating with Espro and several funding agencies with a view to establishing a pilot plant in the Institute and eventually a production facility in Sault Ste. Marie.

b) Douglas-fir Tussock Moth

A Canadian viral insecticide for Douglas-fir tussock moth called Virtuss and the USDA Forest Service product called TM BioControl-1 were both registered in Canada in 1983. In 1983, the last outbreak of Douglas-fir tussock moth in B.C. terminated and neither of these products has been used operationally.B.C. Forest Service holds supplies of sufficient TM BioControl-1 to trat 8,000 ha and sufficient Virtuss to treat 1,400 ha. An outbreak of Douglas-fir tussock moth is predicted for 1991; these products will be applied operationally if the outbreak occurs.

The recommended dosage of virus for Douglas-fir tussock moth is 2.5×10^{11} PIB/ha in either an aqueous, molasses and Orzan tank mix or an emulsifiable oil tank mix applied at 9.4 L/ha. Non-replicated trials in 1982 indicated that a lower dosage. 8.3×10^{10} PIB/ha, gave acceptable results. The virus is known to spread and "seeding" it into the insect population using widely spaced swaths has been suggested.

c) Redheaded Pine Sawfly

Lecontvirus, for control of redheaded pine sawfly, was registered in Canada in 1983. It is the only viral insecticide which is routinely used on an operational basis in Canada. Our principal client has been the Ontario Ministry of Natural Resources, although Quebec Department of Energy and Resources used Lecontvirus experimentally in the 1970's and have requested material for 1991. Dosage is 5×10^9 PIB/ha applied in 10.0 L/ha from the air and 20.0 L/ha with ground spray equipment. The virus is produced inexpensively by treating heavily infested plantations and harvesting diseased and dead colonies of larvae. Between 1976 and 1990, 590 red pine and jack pine plantations with a total area of 4,855 ha have been treated.

d) European Pine Sawfly

A registration petition for Sertifervirus to control European pine sawfly was submitted in 1985 and is still being evaluated. The petition was based on the USDA Forest Service Neochek-S petition. The American product was registered by EPA in 1983 for use in the USA. European pine sawfly virus was extensively used on infested Scot's pine Christmas tree plantations in Ontario in the 1950's and 1960's with no thought given to registration and no records kept of areas treated. This insect is currently only a minor pest. Between 1976 and 1990 only 4 plantations, with a total area of 160 ha, have been treated. However, if a registration is obtained for Sertifervirus, greater use will be made of this product. Recommended dosage of 5×10^9 PIB/ha is the same as that for Lecontvirus. Sertifervirus is also produced by spraying heavily infested plantations and harvesting diseased and dead colonies of larvae.

APPLICATION OF DISPARVIRUS AGAINST GYPSY MOTH IN ONTARIO IN 1990.

A report to the 18th Annual Forest Pest Control Forum

(Ottawa, Ontario. 20-22 November 1990)

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Application of Disparvirus against gypsy moth in Ontario in 1990.

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M.B.E. Cunningham, P. Ebling and D. Frech.

Summary

Following successful Disparvirus trials in 1989 with a double application of $5X10^{11}$ PIB/ha (total 10^{12} PIB/ha) in an emitted volume of 5.0 L/ha, a reduced emitted volume of 2.5 L/ha was tested in 1990 using the same dosage as in 1989 and this was compared to 5.0 L/ha. The aqueous tank mix for both treatments contained 25% v/v molasses, 10% w/v Orzan LS, as a sunscreening agent, and 2% v/v Rhoplex B60A sticker. A Cessna Ag-truck fitted with 4 Micronair AU 4000 rotary atomizers was used for the 2 applications, 5 days apart, on mainly first instar larvae. Each treatment was applied on three plots about 10 ha in area and a further 3 plots were selected as checks. Pre-spray gypsy moth egg mass densities ranged from 2280 to 8900/ha in the 6 treated plots and from 2390 to 6690/ha in the 3 check plots.

In addition to defoliation estimates and egg mass counts, pupal counts in burlap traps and counts of male moths in pheromone traps were used in the assessment of the treatments. The criteria for a successful treatment on gypsy moth is defoliation of oak not exceeding 40% and post-spray egg mass densities below 1200/ha. In the 2.5 L/ha treatment, one plot had 46% defoliation, and two plots had post-spray egg mass densities above 1200/ha. Population reductions due to treatment (Abbott's formula) were 73, 82 and 90%. In the 5.0 L/ha treatment, defoliation ranged from 29 to 38% compared to 77 to 93% in the check plots. The plot with the highest pre-spray egg mass density of 8900/ha had a post-spray density of 1620/ha which was above the 1200/ha threshold; the other two were below the threshold. Population reductions due to treatment of 87, 91 and 95% were calculated for the 5.0 L/ha treatment. The 2.5 L/ha emitted volume was considered to be only marginally effective and 5.0 L/ha remains the recommended volume for application of Disparvirus using an aqueous tank mix.

Introduction

Aerial spray trials were conducted in Lindsay District in 1988 when a double application of Disparvirus using $1.25X10^{12}$ PIB/ha (total $2.5X10^{12}$ PIB/ha) in an emitted volume of 10.0 L/ha gave excellent control when applied on mainly first instar larvae. It requires about 1,000 gypsy moth larvae to produce this dosage and both the dosage and emitted volume were considered to be too high for operational use. In 1989, trials were again conducted in Lindsay District. The dosage was reduced to a double application of $5X10^{11}$ PIB/ha (total 10^{12} PIB/ha) and emitted volumes of 5.0 and 10.0 L/ha were tested. The aqueous tank mix contained 25% v/v molasses, 10% w/v Orzan LS and 2% v/v Rhoplex B60A sticker. Applied on first and second instar larvae, the 5.0 L/ha application was as good as the 10.0 L/ha and the lower dosage gave satisfactory results. Hence, the recommendation for Disparvirus application was revised accordingly.

An emitted volume of 5.0 L/ha is still higher than volumes used for Bacillus thuringiensis applications which are usually less than 2.0 L/ha. It was therefore decided to test Disparvirus in the aqueous tank mix at a double application of $5X10^{11}$ PIB/ha (total 10^{12} PIB/ha) in 2.5 L/ha and compare this to the same dosage in 5.0 L/ha.

Experimental plots and spray application

Six treatment plots, each about 10 ha in area, and three check plots were selected in an area of recent gypsy moth infestation in Simcoe District. Plots were all west of the town of Simcoe and within 25 km of the town. The same dosage was applied on all 6 plots. It was a double application of $5X10^{11}$ PIB/ha (total 10^{12} PIB/ha). Two different emitted volumes, 5.0 L/ha and 2.5 L/ha, were tested. The tank mix contained 25% v/v molasses, 10% w/v Orzan LS, a lignosulphonate used as a UV protectant, and 2% v/v Rhoplex B60A sticker. The first spray application was on May 14th and the second, 5 days later, on May 19th. The FPMI Cessna Ag-truck fitted with 4 Micronair AU 4000 rotary atomizers was used for both applications. Meteorological conditions during the applications are given in Table 1. Gypsy moth larvae were mainly in the first instar and insect development on the two application dates is given in Table 2. Leaves were about 50% expanded on red oak and 25% expanded on white oak at the time of application.

Kromekote cards were placed at 15m intervals at right angles to flight lines in the plots where this was feasible. Results of the analysis of these cards are given in Table 3.

Table 1. Meteorological conditions during spray applications.

Date	Air temp at 10m (°C)	Ground temp at 1m (°C)	% RH	Wind km/h
May 14	2.8-7.8	2.3-8.3	93.5-91.8	1.0-2.6
May 19	6.4-7.4	6.0-7.9	81.0-79.0	1.0-3.0

Table 2. Larval development at time of applications.

Date	% L1	%L2	%L3
May 14	99.8	0.2	0
May 19	84.8	10.0	5.2

Table 3. Spray card deposit on Kromecote cards.

Plot	Emitted volume (L/ha)	Application number	NMD (µm)	VMD (µm)	Dmax (µm)	No. of droplets cm^2 (±SE)
1	5.0	1	42.2	124.9	444.1	21.0 ± 2.7
		2	31.8	91.4	308.4	12.1 ± 0.9
2	5.0	1	43.4	164.6	378.3	12.7 ± 2.6
		2	29.8	75.6	178.6	9.2 ± 2.1
3	5.0	1	51.5	236.0	378.3	12.1 ± 0.8
		2	34.1	87.0	211.0	3.6 ± 0.6
4	2.5	1	48.3	143.0	493.2	63.4 ± 7.4
		2	46.6	185.2	350.0	5.3 ± 0.8
5	2.5	1	37.3	153.1	425.2	35.4 ± 3.3
		2	41.2	147.6	250.0	3.1 ± 0.8
6	2.5	1	43.9	145.0	459.2	26.6 ± 2.8
		2	20.4	132.1	450.0	9.3 ± 0.8

Assessment

Egg mass counts were made on ten $10m^2$ (0.01 ha) sub-plots in each treated and check plot using methods developed by Forest Insect and Disease Survey staff. Numbers were converted to egg masses per hectare. Counts were made in early May before hatching commenced and the same plots were re-examined in mid-October. Treated and check plots were paired on the basis of pre-spray egg mass densities and reduction in egg mass density was calculated using a modified Abbott's formula.

Pupal counts were made from burlap traps on three oak (red or white) trees in each of the ten 0.01 ha sub-plots used for egg mass counts in all treated and check plots. Strips of burlap 45 cm wide were folded double and nailed to the trunks of trees. The circumference of the trees was measured and pupal counts were converted to pupae/m of burlap. Pupal counts were made during the week of July 9-13.

Pheromone trapping was undertaken and 3 traps were placed in each treated and check plot on June 9-10. Lures were supplied by Dr. B. Leonhardt of the USDA Laboratory at Beltsville, Md; the concentration of pheromone was greatly reduced to avoid excessively high catches in green Multipher gypsy moth traps containing a dichlorovos strip to kill the male moths. Traps were hung 12.5m from the ground and 0.5m from a tree trunk. The traps were removed on Aug. 3 at the end of the flight period and the catch of male moths counted.

Defoliation estimates were made on 5 red oak or white oak 46-cm branch tips collected at mid-crown from trees in the ten 0.01 ha sub-plots used for egg mass counts. This was done at 8 weeks after the first spray application when larvae had ceased feeding and were either pupating or dead. A total of 50 branch tips was examined in each treated and each check plot. An estimate was made of the amount of foliage consumed on each branch and a mean was calculated for the plot.

Results

Pheromone trap counts of male moths are given in Table 4. Compared to check plots, the reduction in catches in the 2.5 L/ha treatment were 28, 36 and 46% and in the 5.0 L/ha treatment were 31, 42 and 78%.

Table 4. Moth catches in pheromone traps.

Plot no.	Emitted volume (L/ha)	Mean no.of moths/trap in treated plots (n=3)	Mean no. of moths/trap in corresponding check plots (n=3)	% catch reduction
1	2.5	559	1034	46
2	2.5	654	914	28
3	2.5	588	914	36
4	5.0	449	767	42
5	5.0	633	914	31
6	5.0	204	914	78

Pupal counts are given in Table 5. All counts were significantly lower than corresponding check plots. The mean number of pupae/m of burlap trap in the 2.5 L/ha treatments was 12, 14 and 17 compared to 61, 43 and 43 in corresponding check plots. In the 5.0 L/ha treatment the counts were 2, 8 and 11/m burlap trap compared to 37, 43 and 43 in corresponding check plots.

Egg mass counts in the spring and fall are given in Table 5 along with the population reductions due to the treatments calculated using a modified Abbott's formula. Population reductions in the 3 plots treated at 2.5 L/ha were 73, 82 and 90% and at 5.0 L/ha were 87, 91 and 95%.

Defoliation estimates are given in Table 5. There were significant differences in defoliation of all treated plots compared to check plots except in one of the 2.5 L/ha treatments which had 30% defoliation compared to 46% in its corresponding check plot. The remaining two 2.5 L/ha treatments had 34 and 46% defoliation compared to 77% in the check plot with which both were paired. In the 5.0 L/ha treatment defoliation of 29, 31 and 38% was matched with 77, 77 and 93% in corresponding check plots.

Table 5. Assessment of Disparvirus aerial spray trials.

Plot	Emitted volume (L/ha)	Pupae/m burlap (±SE)	Pre-spray EM/ha (±SE)	Post-spray EM/ha (±SE)	% population reduction due to treatment*	% defoliation of oak
Plot 1	2.5	12 ± 2	2280 ± 339	820 ± 164	90	30
Check	-	61 ± 6	2390 ± 471	8200 ± 1376	-	46
Plot 2	2.5	14 ± 2	3620 ± 267	2230 ± 472	73	46
Check	-	43 ± 5	3430 ± 664	7710 ± 1147	-	77
Plot 3	2.5	17 ± 2	3270 ± 588	1340 ± 305	82	34
Check	-	43 ± 5	3430 ± 664	7710 ± 1147	-	77
Plot 4	5.0	8 ± 2	8900 ± 932	1620 ± 244	87	38
Check	-	37 ± 3	6690 ± 1152	9560 ± 1172	-	93
Plot 5	5.0	11 ± 2	4360 ± 809	930 ± 130	91	29
Check	-	43 ± 5	3430 ± 664	7710 ± 1147	-	77
Plot 6	5.0	2 ± 1	3870 ± 572	420 ± 81	95	31
Check	-	43 ± 5	3430 ± 664	7710 ± 1147	-	77

* Calculated using a modified Abbott's formula.

Discussion

It is difficult to make definitive judgments on the basis of 3 plots per treatment and one year of data, but the inference is that the 5.0 L/ha was superior to the 2.5 L/ha using an aqueous tank mix. Using criteria of defoliation not exceeding 40% and post-spray egg mass densities not exceeding 1200/ha, one plot in the 2.5 L/ha treatment suffered 46% defoliation and two plots had post-spray egg mass densities of 1340 and 2230/ha, respectively. In the 5.0 L/ha treatment, all three plots suffered less than 40% defoliation and only one of the 3 plots had a post-spray egg mass density over 1200/ha. This particular plot had the highest pre-spray egg mass density of 8900 which was reduced to 1620/ha.

This was the first time that pheromone traps have been used as part of the assessment of a virus spray application in Canada. The reduction in the number of male moths was not as dramatic as the reduction in egg mass densities. This, however, is to be expected following a virus application, because the virus has a greater impact on female larvae than on male larvae. Female gypsy moth larvae have 6 instars as opposed to 5 for males, leaving the females longer in the larval stage and hence more chance of succumbing to a virus infection than the males.

Conclusions and recommendations

From these results, it appears that a further reduction in emitted volume from 5.0 L/ha to 2.5 L/ha cannot be recommended with any confidence when using this aqueous tank mix containing molasses and Orzan LS. Results with the double application of $5X10^{11}$ PIB/ha (total 10^{12} PIB/ha) in 5.0 L/ha continues to be the recommended treatment for Disparvirus.

For Disparvirus to become an operational alternative to Bacillus thuringiensis, it will require a Canadian registration and a commercial source of the product. A registration petition for Disparvirus was submitted to Agriculture Canada in April 1990 and is currently being evaluated. FPMI staff have been negotiating with a Maryland company called Espro to establish a pilot plant in the Institute which will be followed in about 2 years by a commercial virus production facility in Sault Ste Marie. Funding is currently being sought from granting agencies. A commercial product will not be available for operational use in 1991, but, along with a Canadian registration, it is hoped that some gypsy moth viral insecticide will be available for use in 1992.

This research was funded, in part, by an Ontario Pesticides Advisory Committee Grant and, in part, by the Ontario Ministry of Natural Resources

November 1990

NORTH CAROLINA GYPSY MOTH PROGRAM
1990 OPERATIONS SUMMARY

The North Carolina Department of Agriculture (NCDA) in cooperation with the North Carolina Division of Forest Resources, the USDA-APHIS-PPQ and the USDA-Forest Service conducted an ongoing program of survey, detection, and eradication for the gypsy moth during 1990. The survey entailed a burlap banding and trapping program in all one hundred counties. The trapping data for North Carolina's gypsy moth program has not been fully summarized. As of October 3, records summarized indicate 3,968 moths caught in 14, 573 pheromone-baited delta traps. A preliminary breakdown of these data by trap type showed that 7,709 comprehensive traps were placed at one trap per four square miles, 2,061 priority traps were placed at high risk sites such as campgrounds, and 4,803 delimiting grid traps placed at treatment and mass-trapping sites. A summary of results to date is included in this report. Based on an evaluation of the final trapping data, egg mass surveys will be conducted during the fall with completion due by the end of December.

Efforts to eradicate known infestations within the state included the use of Bt (Bacillus thuringiensis), Diflubenzuron, and mass trapping. The 1990 treatment program involved operations in eight counties. Ground treatments utilizing hydraulic and mistblower type sprayers were conducted at four locations using two or three applications of Foray 48B™ and/or two applications of Dimilin 25W. Foray 48B™ was applied at the rate of 53 ounces per acre (20 BIU), and Dimilin 25W was applied at the rate of 2 ounces per acre (1/2 AI per acre). Nine sites were treated by air in 1990 and included one site each at Scotland Neck (900 acres in Halifax County), Enfield (200 acres in Halifax County), Windsor (1,350 acres in Bertie County), Drew (300 acres in Bertie County), Woodville-Lewiston (650 acres in Bertie County), Roanoke Rapids (150 acres in Northampton County), Margarettsville (200 acres in Northampton County), Como (1,300 acres in Hertford County), and Grove Hill (50 acres in Warren County). The Warren County site was treated with Gyp-Chek under a cooperative project with USDA-APHIS and USDA-Forest Service.

AU5000 45° angle

The aerial treatments were conducted using two Cessna AgTrucks each equipped with eight Micronair rotary atomizers. Two applications of Foray 48B™ were made at the rate of 53 ounces per acre (20 BIU). The first application was made on Saturday, April 7, and completed on Monday, April 9. The second application was made on Wednesday, April 18, and completed on Friday, April 20. Several of the aerial sites received ground treatments at the center of the infestation using either Foray 48B™, Diflubenzuron or Sevin®.

Weather patterns during the spray operations were generally fair. The wind direction was primarily from the northeast and northwest resulting in a dry air mass with low relative humidity, 45% to 60% in the early morning (prior to 11:00) and 32% to 38% in the afternoon. Winds stayed within the contract limits of 8 mph or less, averaging 3-4 mph over the course of each operation. There was no rainfall during the first round of treatments; however, the start of the second round was delayed approximately two hours due to a light misty rain early in the morning. Temperatures during the spray operations remained relatively cool, allowing for both morning and afternoon spray operations. Temperatures ranged from a low of 32° to a high of 78°.

A summary and description of the treatment sites is included in this report.

County	Total Adult Traps C	Total Adult Traps P	Total Adult Traps +	Positive Traps C	Positive Traps P	Positive Traps +	Multiple Traps C	Multiple Traps P	Multiple Traps +	Total Moths
Lee	58	2		1						1
Lenoir	89	5								0
Lincoln										*
McDowell		5								0 *
Macon	89	142			1					1
Madison		11								0 *
Martin	103	6	9	2			1			3
Mecklenburg	116	10		1						1
Mitchell		3								0
Montgomery	116	13								0
Moore	145	4		2	1		1			4
Nash	121	6	26	8	1			1		10
New Hanover	49	12	76							0
Northampton	131	42	350	13	8	52	3	1	23	142
Onslow	120	77		2	5					7
Orange	95			3			1			4
Pamlico	80	3		1						1
Pasquotank	51	101		22	42		7	12		105
Pender	142	5								0
Perquimans	61	53		8	10		2	1		22
Person	98			15			6			22
Pitt	142	18	7		1	1				2
Polk										*
Randolph		1								0 *
Richmond	94	8								0
Robeson	217	16								0
Rockingham										*
Rowan	113									0
Rutherford										*
Sampson	197	30	60	3	3	3	1	2		18
Scotland	62	7								0
Stanly	98	2								0
Stokes										*
Surry		2								0 *
Swain		58			3					3 *
Translyvania		15								0 *
Tyrrell	81	19		8	3		2			14
Union	143	3			2			1		5
Vance	66	8	121	9	3	2	2	2		23
Wake	194	27		4						4
Warren	97	2	424	2	2	114	1	1	99	1,146
Washington	75	34		2	1					3
Watauga		11								0 *
Wayne	109	23		1						1
Wilkes	157	16		1			1			2
Wilson	80	4								0
Yadkin										*
Yancey		7								0 *
TOTALS	7,709	2,061	4,803	317	339	446	113	149	222	3,968

C = Comprehensive (1/4 sq.mi.) P = Priority (High Risk) + = 25/sq.mi. to 9/acre

NORTH CAROLINA GYPSY MOTH PROGRAM
1990 GYPSY MOTH TRAPPING DATA

County	Total Adult Traps C	Total Adult Traps P	Total Adult Traps +	Positive Traps C	Positive Traps P	Positive Traps +	Multiple Traps C	Multiple Traps P	Multiple Traps +	Total Moths
Alamance	109			4						4
Alexander										*
Alleghany		8			2					2 *
Anson	113	5								0
Ashe		3								0 *
Avery		5			2			1		4 *
Beaufort	204	41		8	1		1			10
Bertie	188	64	834	10	5	60	2		9	93
Bladen	201	18								0
Brunswick	144	14								0
Buncombe		15								0 *
Burke		18								0 *
Cabarrus										*
Caldwell	73	7								0
Camden	46	19		24	8		19	6		132
Carteret	55	60	214	4	7	29		2	4	49
Caswell	99	1		5						5
Catawba										*
Chatham	140	19		2	1					3
Cherokee		19	25							0 *
Chowan	46	66		6	7		2	1		16
Clay	32	82	591			3			2	5
Cleveland										*
Columbus	207	3								0
Craven	113	32	1	1	1					2
Cumberland	132	32	556	4		22			5	44
Currituck	63	19		35	8		24	4		650
Dare	94	382		20	181		7	104		712
Davidson	120	21	10	1			1			2
Davie										*
Duplin	179	7		2	1					3
Durham	71	8		1			1			2
Edgecombe	118	12	25	3	2		2			10
Forsyth	94									0
Franklin	79									0
Gaston										*
Gates	76	32		24	9		11	4		93
Graham		20								0 *
Granville	120	2		14	1		2			17
Greene	58									0
Guilford	149	5	460	3		20	1		6	43
Halifax	167	6	692	18		97	7		61	379
Harnett	140	7								0
Haywood	67	60								0
Henderson		5								0 *
Hertford	80	44	225	12	12	35	3	5	10	108
Hoke	76	12								0
Hyde	114	23	97	7	1	8	2		3	30
Iredell										*
Jackson	79	39			1					1
Johnston	183	7		1	3			1		5
Jones	91	8								0

GYPSY MOTH TREATMENTS IN NORTH CAROLINA
1974 - 1990

YEAR	LOCATION (COUNTY)	SITE DESCRIPTION	TOTAL TREATMENT ACRES	MATERIAL	RECURRENCE
1974	Winston-Salem (Forsyth)	School	1,050	Carbaryl	None.
1979	Land Harbors (Avery)	Residential	1,370	Diflubenzuron	None.
1982	Raleigh (Wake)	Residential	370	Bt (Dipel)	None.
1982	Selma (Johnston)	Campground	200	Diflubenzuron	None.
1983	Beaufort (Carteret)	Lumberyard	150	Disparlure Flakes	Yes.
1984	Locust Gap (Watauga)	Forested	2,360	Bt (Dipel) Diflubenzuron	Scattered moths outside treatment area.
1984	Linwood (Davidson)	Lumberyard	6	Diflubenzuron	Yes.
1984	Beaufort (Carteret)	Lumberyard	4	Bt (Dipel)	Yes.
1985	Enfield (Halifax)	Forested	12	Diflubenzuron	None.
1985	Roanoke Rapids (Halifax)	Forested	8	Diflubenzuron	None.
1985	Frisco (Dare)	Campground	16	Bt (Dipel)	None.
1985	Greensboro (Guilford)	Residential	6	Bt (Dipel)	Yes.
1985	Locust Gap (Watauga)	Forested	4,180	Bt (Dipel)	None.

YEAR	LOCATION (COUNTY)	SITE DESCRIPTION	TOTAL TREATMENT ACRES	MATERIAL	RECURRENCE
1985	Wendell (Wake)	Residential	4	Bt (Dipel)	None.
1985	Raleigh (Wake)	Residential	0.2	Diflubenzuron	None.
1985	Beaufort (Carteret)	Lumberyard	2	Diflubenzuron	Yes.
1986	Greensboro (Guilford)	Residential	0.2	Bt (Dipel)	Yes.
1986	Enfield (Halifax)	Single Tree	0.2 0.1	Diflubenzuron Bt (Dipel)	None. Infestation in the vicinity.
1986	Jackson (Northampton)	Residential	1.5	Bt (Dipel)	None.
1986	Plymouth (Washington)	Residential	40 4 3	Bt (Dipel) Carbaryl Acephate	None. None. None.
1986	Shawboro (Currituck)	Forested	40 3	Bt (Dipel) Acephate	Yes. Yes.
1986	Southern Shores (Dare)	Residential	5	F1 Sterile Male Release.	Yes.
1986	Linwood (Davidson)	Lumberyard	3	Carbaryl	Yes.
1986	Pine Knoll Shores (Carteret)	Residential	2.5	Acephate	Yes
1987	Pine Knoll Shores (Carteret)	Residential	12 6	Diflubenzuron Bt (Dipel)	None.
1987	Fires Creek Area (Clay)	Forested	9,308	Bt (Dipel) Diflubenzuron	Yes.
1987	Shawboro (Currituck)	Forested	3,734	Bt (Dipel)	Yes.
1987	Heartsease (Edgecombe)	Residential	5 3	Diflubenzuron Bt (Dipel)	Yes.
1987	Moonlight (Halifax)	Residential	5	Diflubenzuron	Yes.

YEAR	LOCATION (COUNTY)	SITE DESCRIPTION	TOTAL TREATMENT ACRES	MATERIAL	RECURRENCE
1987	Garysburg (Northampton)	Forested	8	Diflubenzuron	None.
1987	Winton (Gates)	Forested	5	F1 Sterile Male Release	Yes.
1987	Plymouth (Washington)	Forested	0.5	Diflubenzuron	None.
1987	Nahunta (Wayne)	Residential	5	Diflubenzuron	None.
1987	Norlina (Warren)	Residential	0.1	F1 Sterile Male Release	Yes.
1987	Southern Shores (Dare)	Residential	5	F1 Sterile Male Release	Yes.
1988	Wilmington (New Hanover)	Residential	4 12	Bt (Dipel) Diflubenzuron	None.
1988	Heartsease (Edgecombe)	Residential	3	Bt (Dipel)	Yes.
1988	Moonlight (Halifax)	Residential	2	Diflubenzuron	Yes.
1988	Gates Co.	Residential	12	Bt (Dipel) Diflubenzuron	Yes.
1988	Gates Co.	Forested	5	F1 Sterile Male Release	Yes.
1988	Hertford/Gates Co.	Forested	702	Bt (Dipel)	Yes.
1988	Shawboro (Currituck)	Forested	1,702	Bt (Dipel)	Yes.
1988	Spot (Currituck)	Forested	134	Bt (Dipel)	Yes.
1988	Mamie (Currituck)	Forested	800	Bt (Dipel)	Yes.
1988	Clay Co.	Forested	9,119	Bt (Dipel) Diflubenzuron	Yes.

YEAR	LOCATION (COUNTY)	SITE DESCRIPTION	TOTAL TREATMENT ACRES	MATERIAL	RECURRENCE
1989	Henderson (Vance)	Residential	4	Diflubenzuron	Yes.
1989	Norlina (Warren)	Residential	1	Diflubenzuron	Yes.
1989	Greensboro (Guilford)	Residential	8	Diflubenzuron	Yes.
1989	Cashie (Bertie)	Golf Course	18	Bt (Foray)	Yes.
1989	Cashie (Bertie)	Golf Course	154	Bt (Foray)	Yes.
1989	Grove Hill (Warren)	Forested	84	Bt (Foray)	Yes.
1989	Old Trap (Camden)	Forested	72	Bt (Foray)	Yes.
1989	Winton-Ferry Ridges (Hertford-Gates)	Forested	8,114	Bt (Foray)	Yes.
1989	Beech Swamp (Halifax)	Forested	94	Bt (Foray)	Yes.
1990	Fayetteville (Cumberland)	Forested	20	Diflubenzuron	Evaluation continuing.
1990	Piney Green (Sampson)	Residential	2	Diflubenzuron Bt (Foray)	Evaluation continuing.
1990	Ocracoke Village (Hyde)	Residential	3	Bt (Foray)	Evaluation continuing.
1990	Moonlight (Halifax)	Farm	10	Diflubenzuron Bt (Foray)	Evaluation continuing.
1990	Scotland Neck (Halifax)	Forested	1,800	Bt (Foray)	Evaluation continuing.
1990	Enfield (Halifax)	Forested	400	Bt (Foray)	Evaluation continuing.
1990	Windsor (Bertie)	Forested	2,700	Bt (Foray)	Evaluation continuing.

YEAR	LOCATION (COUNTY)	SITE DESCRIPTION	TOTAL TREATMENT ACRES	MATERIAL	RECURRENCE
1990	Drew (Bertie)	Forested	600	Bt (Foray)	Evaluation continuing.
1990	Woodville-Lewiston (Bertie)	Forested	1,300	Bt (Foray)	Evaluation continuing.
1990	Roanoke Rapids (Northampton)	Forested	300	Bt (Foray)	Evaluation continuing.
1990	Margarettsville (Northampton)	Forested	400	Bt (Foray)	Evaluation continuing.
1990	Como (Northampton /Hertford)	Forested	2,600	Bt (Foray)	Evaluation continuing.
1990	Grove Hill (Warren)	Forested	100	Gyp-Chek	Evaluation continuing.

1990 Gypsy Moth Spray Site
Description

1. Windsor, Bertie County. This 1,350 acre consists of a recreational-industrial-municipal use area and a densely wooded swamp adjacent to the Cashie River. The site is immediately to the south and west of the town of Windsor (see Map, Windsor site). Dominant tree species include willow, gum, oak, and southern yellow pine. This site encompasses a 75 acre block treated in 1989 for gypsy moth. Numerous residences, businesses and municipal buildings are within this site, including the Bertie-Martin Regional Jail, the Bertie Public Schools bus garage, the Town of Windsor Sanitary Sewage Disposal Plant, the Cashie Golf Club, and the National Guard Armory. Numerous creeks in the spray block drain into the Cashie River.

Ninety-five moths were recovered from this site in 1989. Ten apparently viable egg masses were observed during the course of a series of egg mass surveys conducted in November and December, 1989. Over twenty thousand egg masses per acre existed in a central "core" area prior to 1989 spray activities, resulting in numerous spent egg masses in this area. The abundance of spent egg masses may be serving to camouflage viable egg masses. Although the origin of this infestation is not known, it may be related to a trucking company which is situated approximately 100 feet from this core area. This site will receive two applications of Bt at 20 BIU/AC with follow up treatments in and around the core area.

2. Drew, Bertie County. This site consists of 300 acres of woodland along the Roquist Pocossin in Bertie County (see Map, Woodville-Lewiston site). It is a swampy, sparsely populated area located approximately 8 miles northwest of the town of Windsor. Dominant tree species include willow, gum, oak, and yellow pine. A total of 95 moths and 4 egg masses were recovered from this site in 1989. The origin of this infestation is not known. This site received two applications of Bt.

3. Woodville-Lewiston, Bertie County. This site consists of 650 acres of woodland along the Roguist Pocossin in Bertie County (see map, Woodville-Lewiston site). It is a swampy, sparsely populated area located approximately 19 miles northwest of the town of Windsor and 11 miles northwest of the proposed treatment site at Drew. Dominant tree species include willow, gum, oak, and yellow pine. A total of 39 moths and 229 egg masses were recovered from this site in 1989. The origin of this infestation is not known. This site received two applications of Bt with follow up treatments to the core area.

4. Margarettsville, Northampton County. This 200-acre site is located in Northampton County immediately south of the Virginia-North Carolina border and is adjacent to the Meherrin River (sse map, Margarettsville site). It is approximately 8 miles west of the dominant tree species being gum and river birch. This area is managed by the Northampton Hunt Club. Thirty-four moths and three egg masses were recovered from this site in 1989. Although the origin of this infestation is not known, it may be associated with the activities of Northampton Hunt Club members or with the forestry industry. This site received two applications of Bt at 20 BIU/AC.

5. Como, Northampton County. This 1,300-acre site is a wooded, swampy area located two miles south of the Virginia-North Carolina border in Northampton and Hertford Counties (see map, Como site). Situated on the Meherrin River, this site straddles the border of Northampton and Hertford Counties. The proposed treatment area is primarily a swampy, wetland area composed predominantly of willows, gums and pines. There are several

residences located within the spray block.

Thirty-nine egg masses and 186 moths were recovered from this area in 1989. The origin of this infestation is not known, but may be related to hunting and fishing clubs in the area or associated with the forestry industry. This site received two applications of Bt at 20 BIU.

6. Roanoke Rapids, Northampton County. This site is a 150-acre island in the Roanoke River. It is located approximately one mile east of the city of Roanoke Rapids and is situated at the intersection of Interstate 95 and the Roanoke River (see map, Roanoke Rapids site). The site lies in Northampton County (the main channel of the river constitutes the county boundary). Interstate 95 bisects the island. The dominant tree species on the island include white oak, red maple, southern yellow pine, virginia pine, gum, and willow. No residences or structures exist on the island.

Eleven moths and ten egg masses were recovered from this site in 1989. Although the origin of this infestation is not known, it may be associated with interstate travel and/or commerce along Interstate 95. This site received two applications of Bt at 20 BIU.

7. Enfield, Halifax County. This 200-acre site is a swampy, wetland area located on both sides of County Road 1001 approximately two miles north of the town of Enfield in Halifax County. Dominant tree species include gum, river birch and willow. No structures or residences are located on this site.

Four egg masses and 135 moth were recovered from this site in 1989. The origin of this site is not known, although it may be related to traffic or to an earlier spot infestation located approximately six southeast of this site. This site received two applications of Bt of 20 BIU.

8. Scotland Neck, Halifax County. This 900-acre site is situated approximately two miles southwest of the town of Scotland Neck, Halifax County, and lies on either side of U.S. Highway 258 (see map, Scotland Neck site). Dominant tree species in the upland portion of this site include white oak, southern yellow pine, and ironwood. The eastern boundary of this spray block lies adjacent to Deep Creek; dominant tree species in this swampy, wetland portion of the spray block are gum, willow and river birch.

Nine hundred moths and 10,011 egg masses were recovered from this site in 1989. A large white oak tree in the center of this site was found to harbor several thousand egg masses. Although the origin of this infestation is not know, it may be related to the activities of a resident who makes periodic visits to New Jersey. Several residences exist in this spray block. This site received two application of Bt with follow up treatments to the core area with Bt and Demilin using ground equipment.

9. Grove Hill, Warren County. This 50-acre site is a rural, sparsely populated, forested area in northeastern Warren County (see map, Grove Hill site). This area is predominantly pine with mixed hardwoods. Gum and river birch are dominant along the creek in the center of this site. A portion of the area was clear cut in 1984.

On hundred and fifty male moths were captured at this site in 1989. An egg mass survey conducted in January, 1990 yielded three egg masses. The origin of this infestation is not known. No residences exist at this site. This site received two applications of the virus Gyp-Chek under a cooperative program with USDA-APHIS and U.S. Forest Service.

California
Jessie Rios

STATE OF CALIFORNIA
DEPARTMENT OF FOOD AND AGRICULTURE
PEST DETECTION/EMERGENCY PROJECTS

California Gypsy Moth Program - 1990

The California Department of Food and Agriculture maintains a statewide detection program for gypsy moth using trap densities of two traps per-square-mile in most residential and densely populated rural areas, and three traps per square mile in urban areas with high numbers of families moving from gypsy moth infested areas of the northeast. High risk sites such as campgrounds, recreational areas, mobile home parks, etc., are trapped at a minimum of one trap per site. Upon catching an adult gypsy moth, trap density is increased to 25 traps per-square-mile in a four-square-mile area around the find. In addition, incoming moving vans from gypsy moth infested areas of the East have their contents inspected upon arrival at their destination. If there are any signs of live gypsy moth eggs, larvae, or pupae, 25 (quarantine) traps are deployed in a square-mile area around the move-in site. If spent pupal cases and old egg masses are recovered, then a single (quarantine) trap is placed on the property.

Eradication treatment occurs when a breeding gypsy moth population is located. Evidence of a breeding population is as follows:

1. Male moth trap catches and one or more other life stages, such as egg masses, larvae, or pupae; or evidence of these life stages, such as cast skins, pupal cases or inviable egg masses.

2. Male moth catches followed by five or more male moths trapped the following year in a 400-meter radius (1/4 mile); or,

3. Viable egg masses, other than those found on objects recently transported from infested areas.

The boundaries of the treatment area are approximately one-quarter-mile radius (ground treatment) to one-half-mile radius (aerial treatment) around the core of the infestation, as determined by moth catches and/or egg masses. Other factors may alter the size or shape of the treatment area such as trapping single moths outside the core, natural barriers to the spread of the moth, the history of moth catches, and the method of treatment. Because of these variables, boundaries are drawn on a case-by-case basis.

The discovery of moths and egg masses in 1989 led to two limited treatment programs in the counties of Marin and Placer during the spring of 1990. The treatment of both sites entailed two applications of Dimilin at 14-day intervals. The applications were made by hydraulic ground spray rigs. There were 12 properties within the Marin County treatment area, and five properties involved in the Placer County treatment area. Post-treatment trapping was at a density of 49 traps per-square-mile in three square miles in Marin County, and six square miles in Placer County. 1990 post-treatment trapping was negative in both Marin and Placer County treatment areas.

[illegible]

1. Data not [illegible] measures [illegible] ... [illegible] ... [illegible]

2. [illegible] which [illegible] ... [illegible] following [illegible]

3. ...ble organism, other than those [illegible] objects actually transported from [illegible]

[illegible] of the [illegible] ... [illegible] ... [illegible] vegetables, [illegible] drawn on [illegible] base

[illegible]

All other 1989 moth capture sites (22), that did not lead to a treatment program, were trapped at a density of at least 25 traps per-square-mile over at least a four-square-mile area. Repeat captures occurred in Grass Valley, Nevada County, and La Mesa, San Diego County. All other 1989 gypsy moth capture sites were negative for 1990. These negative sites will revert to normal detection trapping levels for the 1991 season (see Attachment 1).

During 1990, the statewide gypsy moth detection and delimitation system had approximately 21,000 traps deployed throughout California. In total, 24 adult gypsy moths were captured in eight counties (see Attachment 2). The detection and delimitation trapping system captured 18 gypsy moths in six counties and the quarantine traps captured six gypsy moths in four counties. An egg mass survey was planned for the four multiple catch trap sites: La Mesa and Vista, San Diego County; Carmichael, Sacramento County; and Santa Barbara, Santa Barbara County. Egg mass survey is still in progress in Vista; however egg mass surveys in the other multiple catch sites have been completed. Gypsy moth evidence such as viable egg masses, larva, and pupal cast skins were found at Carmichael, Sacramento County; one female pupal case was found at La Mesa, San Diego County, and no gypsy moth evidence was found at the Santa Barbara County site. Treatment plans have not been made; however, treatment strategies are being discussed for Carmichael and La Mesa, where egg mass survey discovered additional gypsy moth evidence.

ATTACHMENT 1

CALIFORNIA DEPARTMENT OF FOOD AND AGRICULTURE
Pest Detection/Emergency Projects

SUMMARY - 1989/90 GYPSY MOTH TRAPPING ACTIVITY

COUNTY	CITY	1989 CAPTURES	1990 INTENSIVE TRAPPING RESULTS	PROPOSED 1991 TRAPPING LEVELS
Alameda	Berkeley	2	0	3/sq.mi.
Los Angeles	Chatsworth	1	0	3/sq.mi.
	Newhall	1	0	3/sq.mi.
	Sun Valley	1	0	3/sq.mi.
	Woodland Hills	1	0	3/sq.mi.
Marin	Fairfax	2	0	3/sq.mi.
	Novato	1	0	3/sq.mi.
	San Anselmo	2	0	3/sq.mi.
	San Rafael	3	0	3/sq.mi.
	Tiburon	17	0	49/sq.mi.
Nevada	Grass Valley	3	2	25/sq.mi.
Orange	Anaheim	1	0	3/sq.mi.
	Fullerton	1	0	3/sq.mi.
Placer	Roseville	3	0	49/sq.mi.
Sacramento	Carmichael	1	0	3/sq.mi.
San Diego	La Mesa	7	4	49/sq.mi.
	Valley Center	1	0	3/sq.mi.
San Joaquin	Manteca	1	0	2/sq.mi.
San Mateo	Menlo Park	1	0	3/sq.mi.
Santa Clara	San Jose	1	0	3/sq.mi
Shasta	Cottonwood	2	0	3/sq.mi.
Tuolumne	Sonora	1	0	3/sq.mi.
Ventura	Thousand Oaks	2	0	3/sq.mi.

CALIFORNIA DEPARTMENT OF FOOD AND AGRICULTURE
Pest Detection/Emergency Projects

SUMMARY - 1990 GYPSY MOTH FINDS

COUNTY	<--ADULTS TRAPPED--> DETECTION	QUARANTINE	TOTAL ADULTS	PROPERTIES WITH VIABLE EGG MASSES/ PUPAL CASES
LOS ANGELES	3	0	3	0
Diamond Bar (1)				
Lynwood (1)				
Long Beach (1)				
NEVADA	1	1	2	
Grass Valley (1,1)				
SACRAMENTO	0	3	3	0
Carmichael (3)				
SAN DIEGO	7	0	6	0
La Mesa (4)				
Mira Mesa (1)				
Vista (2)				
SAN JOAQUIN	0	1	1	
Stockton (1)				
SANTA BARBARA	4	0	4	0
Santa Barbara (4)				
SANTA CLARA	1	1	2	
San Jose (0,1)				
Los Altos Hills (1,0)				
SANTA CRUZ	2	0	2	
Aptos (1)				
Santa Cruz (1)				
	18	6	24	0

08/08/90

Michelle Frank

1990 Green Mountain National Forest Gypsy Moth Suppression Project

In the spring of 1990 the Green Mountain National Forest (GMNF) suppressed gypsy moth (GM) on approximately 3200 acres of the Middlebury District. The project was conducted jointly with the State of Vermont Division of Forests, Parks and Recreation. This was the first time the two agencies had collaborated on a suppression project. The Incident Command System (ICS) was also used for the first time to plan and implement the project. The objectives of the GMNF were to reduce defoliation to less than 30% and to lower egg mass (EM) densities below 1000 per acre. The Forest also decided to delay all harvests in the proposed treatment blocks.

The Middlebury Ranger District was sprayed on May 30, 1990 from 5:00 am to 10:00 am. All blocks were sprayed that day. At this time larval development was 17% firsts, 70% seconds, and 13% third instar. Prespray defoliation averaged 10% and EM counts ranged from 1100 to 5300 per acre. The aircraft used was a Piper Aztec equipped with 34, 8008 flat fan nozzles. Foray 48B® was applied undiluted at a rate of 64 ounces and 24 BIU's per acre. Aircraft speed was 150 mph and the release height was 50 feet above the canopy and the swath width approximately 150 feet.

Post spray evaluations for defoliation and egg mass surveys were done in July and September respectively. Post spray defoliation averaged 15% in spray blocks and 70% in control blocks. Egg mass surveys showed the mean EM densities for all blocks to be less than 1000 per acre, however some isolated areas within the blocks had as high as 3300 EM per acre.

Overall the project satisfied its goals of reducing defoliation and EM densities. The project had many "firsts." The State of Vermont and GMNF felt that ICS was a useful tool and would use it again. The undiluted application of Foray 48B® at 64 ounces and 24 BIU per acre was also wekk received. Both groups benefited from the joint contract and the sharing of resources such as personnel and technical expertise.

STATE OF VERMONT

1990 COOPERATIVE GYPSY MOTH SPRAY PROJECT
DEFOLIATION ASSESSMENTS

INTRODUCTION

On 27 and 28 May, 7,514 acres were sprayed in Chittenden County at the request of the following municipalities: Burlington, South Burlington, Colchester, Essex (town and village), and Winooski. All spray blocks were treated once with Foray 48B (*Bacillus thuringiensis* var. *kurstaki*), applied undiluted by small, twin-engine, fixed wing aircraft at the rate of 24 Billion International Units (64 oz.) per acre. Larvae were at optimum development size (46% instar 1; 51% instar 2; 3% instar 3) for the Foray to be effective, but noticeable defoliation (average of 9%) had already taken place prior to treatment. Weather conditions on the days of spraying were excellent and no rain was received for at least 30 hours after treatment.

To evaluate defoliation, 10 to 30 oak trees per block (depending on block size) were selected and flagged prior to treatment, for a total of nearly 500 trees. These were individually rated from the ground (using binoculars) to estimate actual percent defoliation to the nearest five to 10 percent. Trees were randomly selected to represent a broad geographical representation of each block. Trees were rated on the day of treatment to estimate prespray defoliation and again in mid-July to estimate final defoliation. Not every spray block was rated for defoliation, but the majority of them, especially the larger blocks, were rated.

As a comparison to the spray blocks, five additional unsprayed areas that had high enough prespray egg mass counts to qualify for insecticide treatment, were assessed in the same way as the spray blocks. Thirty trees in each of these untreated blocks were used for defoliation estimates.

RESULTS AND DISCUSSION

Defoliation in town project spray blocks averaged 12 percent compared to 52 percent in the unsprayed areas. Defoliation on the days of spraying averaged nine percent. Thus, on average, only three percent additional defoliation took place after spraying.

Some moderate (30-60%) to heavy (over 60%) defoliation took place in some spray blocks, but in most blocks this was confined to scattered individual trees. These tended to be large roadside trees that were loaded with egg masses laid in 1989. On 19 July, 34 of the blocks were surveyed by helicopter to evaluate degree of foliage protection. Of the 5,661 acres aerially evaluated,

175 acres (3% of the area) had visible moderate to heavy defoliation. Most blocks looked good, but Suites and Lost Nation Blocks in Essex were largely (75-80%) defoliated, and Gentes (Essex), Edwards (Essex), Canyon Estates (Colchester), West Street (Essex), and Pinewood (Essex) had some areas of poor protection.

Trees selected on the ground, with some exceptions, were fairly representative of average defoliation in the block. In most cases, blocks that averaged above 15 percent defoliation received some heavy defoliation of scattered individual trees, with the following exceptions:

1. Gilbrook Block, (Winooski) - although a few of the rated trees were moderately defoliated, the block looks very good overall.

2. Porters Point (Colchester) - except for some edge trees that missed being sprayed, no heavy defoliation was reported.

A few blocks that had areas of poor foliage protection (as evaluated from the ground) are worthy of mention:

1. Pinewood Block (Essex) - the upper Skyline Drive/Forest Road area received heavy defoliation of scattered individual trees, with nearly complete defoliation on some trees.

2. Edwards Block (Essex) - many trees here received 55 to 60 percent defoliation.

3. Canyon Estates (Colchester) - a section along Colchester Road (Route 2A) received moderate to heavy defoliation. This was outside of the area where trees were evaluated for defoliation.

Even though there were a few problem areas, it is obvious that without insecticide treatment, most of the areas sprayed would have received much heavier defoliation.

All spray blocks will be surveyed this fall for postspray egg mass counts to determine population reduction and the need for any retreatment in 1991.

Ronald S. Kelley
Forest Protection Specialist
Vermont Department Forests, Parks & Recreation
6 August 1990

STATE OF VERMONT

1990 GYPSY MOTH SPRAY PROJECT
Defoliation-Ground Ratings

Spray Blocks

Block	Ave. % Defoliation	Range
	BURLINGTON	
North Avenue	12.7	0-30
	SOUTH BURLINGTON	
Airport	5.0	0-25
	WINOOSKI	
Gilbrook	21.5	10-50
	ESSEX	
Pinewood	16.8	0-50
Pinecrest	7.0	0-15
New England	5.0	5
Gentes	5.0	5
Edwards	23.9	5-65
Hillside	2.5	0-5
West Street	19.0	0-75
	COLCHESTER	
Mallets Bay	22.8	5-50
Mallets Bay Extension	16.5	0-25
Town Farm	20.0	5-30
Trailer Park	11.3	5-20
Bayside	1.5	0-10
Clay Point	9.0	5-20
Oak Terrace	6.3	5-10
Pheasant Woods	23.4	5-50
Sunderland Woods	3.8	0-5
Camp Johnson	3.8	0-5
Canyon Estates	9.5	0-25
Porters Point	21.5	0-50
Creek Farm	10.0	5-10
Kenya Road	10.0	5-40
Davis 1	7.5	5-20
AVE.	12.1	BLOCK RANGE: 1.5-23.9

Prespray defoliation averaged 8.9% and ranged up to 30% per tree.

Block	Ave. % Defoliation	Range
	UNTREATED CHECK BLOCKS	
Brigham Hill (Colch/Essx)	41.0	15-90
Sandbar (Milton)	42.8	30-60
Essex Nursery	79.2	30-100
Raymond Road (Colch)	21.0	10-60
I-89 (Colch)	77.0	60-90
AVE.	52.2	BLOCK RANGE: 21.0-79.2

Prespray defoliation averaged 9.9% and ranged up to 40% per tree.

[illegible]

[illegible] pesticides [illegible] tested

[illegible] and pheromone baits were evaluated.

[illegible] carrier for [illegible] oil base [illegible]

[illegible] enhance the activity of [illegible]

[illegible] observed when [illegible]

[illegible] for 9 or more days, similar to [illegible]

[illegible] mortality of [illegible] and [illegible] following [illegible] exposure to oak seedlings [illegible]

Report of Laboratory and Field
Pesticide Testing Activities - APHIS - S&T

Win McLane
USDA, APHIS, S&T
Otis Methods Development Center
Building 1398
Otis ANGB, MA 02542

Laboratory

A number of registered and experimental pesticides were tested in the laboratory during the past year. *Bacillus thuringiensis* (Bt), insect growth regulators, neem products, feeding stimulants and pheromone beads were evaluated.

ABG-7022, an experimental carrier for mainly oil base formulations, was tested extensively and was found to enhance the activity of Dipel 8L and Dipel powder formulations. Faster kill was observed when using the ABG 7022 formulation. Residual activity continued for 9 or more days, similar to that of Foray 48B.

TABLE 1. Percent mortality of 2nd instar gypsy moth larvae and seedling defoliation following exposure to oak seedlings treated with Bt.

Material	BIU gal/acre	Percent mortality				Percent Defoliation	
		2 days	4 days	6 days	10 days	2 days	4 days
Dipel 2x + ABG-7022	14.52	73	97	100		1	1
Dipel 2x + H2O	14.52	4	11	68	99	30	40
Foray 48B	14.52	38	79	100		3	6
Thuricide 32LV	14.52	31	75	97	99	3	7
Dipel 8L	14.52	10	20	83	97	20	30
Dipel 2x + ABG-7022	7.26	37	47	90	98	7	13
Dipel 2x + H2O	7.26	2	4	17	35	34	52
Foray 48B	7.26	19	50	90	94	5	8
Thuricide 32LV	7.26	10	42	97		13	14
Dipel 8L	7.26	0	1	3	19	44	75
Dipel 2x + ABG-7022	3.63	38	65	96	99	5	14
Dipel 2x + H2O	3.63	0	3	14	27	46	100
Foray 48B	3.63	11	31	95	100	18	30
Thuricide 32LV	3.63	14	67	94	99	9	9
Dipel 8L	3.63	0	3	13	35	48	100
Control (ABG-7022)	Carrier	1	1	2	2	58	100

TABLE 2. Percent larval mortality and seedling defoliation after exposure of 2nd instar gypsy moth larvae to seedlings treated with various dosages of Dipel 8L and ABG-7022.

Formulation	Dosage BIU/gal/acre	Percent mortality			Percent defoliation		
		2 day	4 day	8 day	2 day	4 day	8 day
8L + ABG-7022	1	42	57	75	10	20	26
8L + Water	1	0	0	2	90	100	
8L + ABG-7022	2	45	69	94	5	11	12
8L + Water	2	1	1	3	77	99	99
8L + ABG-7022	4	47	78	98	3	7	8
8L + Water	4	0	1	5	64	91	91
8L + ABG-7022	6	57	85	98	2	5	6
8L + Water	6	2	2	35	27	71	73
8L + ABG-7022	8	58	84	94	3	6	12
8L + Water	8	1	3	34	36	92	92
Control	--	0	0	1	80	98	98

TALBE 3. Percent mortality of 2nd instar gypsy moth larvae after exposure to oak seedlings treated with a number of Bt formulations at 12 BIU/gallon/acre and exposed to natural sunlight.

Material	Percent mortality											
	Day 0[1/]			Day 2			Day 7			Day 9		
	4 day[2/]	8 day	12 day	4 day	8 day	12 day	4 day	6 day	12 day	4 day	8 day	12 da
MYX-2284	34	92	98	43	95	100	12	17	25	0	11	17
MYX-2728	5	16	30	85	100		4	17	25	0	9	12
MYX-2728-168	18	91	99	14	97	100	0	8	24	0	3	3
MYX-7275	3	26	55	6	59	74	1	3	6	0	1	2
MYX-7275M	29	75	91	37	97	100	0	3	5	2	4	6
MYX-8242	86	100		45	99	100	2	19	24	5	17	18
FORAY 48B	48	93	100	73	100		10	22	28	10	36	47
Dipel 8L	9	39	59	19	67	84	0	1	2	1	3	3
ABG-7022 + Dipel 2X	86	94	98	61	93	100	41	56	65	14	40	46
ABG-7022 + Dipel 2X + Emul	72	91	98	72	96	98	28	54	70	0	11	16
CONTROL	0	1	2	0	2	5	0	0	1	0	0	1

1/ Days of outside exposure

2/ Days larvae exposed to plants

As a result of favorable laboratory data with ABG-7022 field tests were conducted in Pennsylvania. Field results are reported later in this report.

CGA-184699, an insect growth regulator from Ciba-Geigy was screened in the laboratory and compared to Dimilin. CGA-184699 was as effective as Dimilin 25W at dosages presently registered for use against gypsy moth. Dimilin was more effective at very low dosages (O.D156-0.0078 oz. AI/acre). Both materials experienced little wash-off when exposed to heavy rainfall.

At this time there are no plans to do field work with CGA-184699.

TABLE 4. Percent larval mortality and seedling defoliation following gypsy moth larvae exposure to red oak seedlings treated with CGA-184699 and Dimilin 25W at various dosages.

Material	lbs.AI Gal/acre	Percent mortality 4 day[1/]	8 day	11 day	Percent defoliation 4 day
CGA-184699	.0625	26	98	100	98 [2/]
Dimilin 25W	"	13	100	--	81
CGA-184699	.0156	22	97	100	99
Dimilin 25W	"	18	100	--	100
CGA-184699	.0039	19	96	100	100
Dimilin 25W	"	20	100	--	78
CGA-184699	.00097	11	67	95	93
Dimilin 25W	"	19	98	100	85
CGA-184699	.00048	6	17	51	90
Dimilin 25W	"	24	89	97	97
CGA-184699	.00024	1	7	42	91
Dimilin 25W	"	4	53	90	99
Control	--	0	1	1	100

1/ Days after original exposure to treated seedlings

2/ Larvae changed to artificial diet as seedlings were near complete defoliation

TABLE 5. Percent larval mortality and seedling defoliation following gypsy moth larvae exposure to red oak seedlings treated with CGA-184699 and Dimilin 25W at .0625 lbs. AI/gallon/acre then exposed to rainfall.

Material	Inches rain	Percent mortality 4 day [1]	Percent mortality 7 day	Percent defoliation 4 day [2]
CGA-184699	--	7	100	88
"	1.0	2	100	94
"	2.0	4	100	74
"	3.0	16	100	86
"	5.0	20	100	66
Dimilin 25W	--	3	100	82
"	1.0	3	100	86
"	2.0	7	100	86
"	3.0	9	100	88
"	5.0	9	100	78
Control	--	0	2	89

1/ Days after orig nal exposure to treated seedlings

2/ Larvae changed to artificial diet as seedlings were near complete defoliation

CGA-237218, a Ciba-Geigy formulation of (Bt) was tested and found to be more effective than Dipel 8L and less effective than Dipel 8AF and Foray 48B.

A number of Ecogen and Mycogen (Bt) samples were tested and found to be less effective than the presently registered formulations.

Foray 75 BFC (75 BIU/gal) was tested and found to be as effective as Foray 48B against gypsy moth larvae.

Three formulations of Futura (Bt) from Chemagro Limited were tested in the laboratory. Futura XLV was the most effective of the formulations tested with activity being slightly less than that of Dipel 8AF and Foray 48B. The XLV-HP and O formulations weathered poorly. Futura is registered in Canada and used against budworm.

Margosan-O (neem) from W. R. Grace was tested in the laboratory and found to be effective against 2nd instar gypsy moth larvae. Previously tested formulations of neem were found to have little effect. Most mortality occurred 10 or more days after exposure time. When exposed to 0.10 inches of rain 4 hours after treatment most material washed off the oak foliage.

Margosan-O was field tested in 1990 against gypsy moth in Pennsylvania. Results are reported later in this report.

TABLE 6. Percent larval mortality following exposure to oak seedlings treated with Margosan-O at various dosages.

Dosage/Acre lbs.AI/gal	Oz./Form acre	Percent mortality 10 days	16 days	20 days	25 days
.0054	32	78	99	100	
.0027	16	23	49	88	99
.00135	8	20	34	75	93
.00067	4	15	31	47	73
.00033	2	11	21	29	51
.000168	1	0	3	4	15
.000084	.5	1	9	13	29
.000042	.25	1	4	18	31
Control		1	2	7	7

TABLE 7. Percent larval mortality following exposure to oak seedlings treated with Margosan-O at various dosages and exposed to rainfall.

Dosage/Acre lbs.AI/gal	Oz/Form acre	Inches rain	Percent mortality 8 days	14 days	20 days	25 days
.216	128	--	10	91	99	100
"		.10	4	9	42	64
.0108	64	--	3	60	92	100
"		.10	2	3	5	25
.0054	32	--	8	60	93	100
"		.10	0	0	0	4
.0027	16	--	8	36	90	96
"		.10	2	3	12	29
Control	--	--	0	0	0	0
"		.10	0	0	0	0

Coax, a feeding stimulant from CCT Corporation, was tested in the laboratory against 2nd instar gypsy moth larvae. Tender oak seedlings were sprayed with Coax and then exposed to gypsy moth larvae for various amounts of time. Percent defoliation of seedlings was recorded to determine effectiveness.

Data indicate increased feeding on plants treated with Coax at high dosages. Tests have not been conducted using Coax in a Bt formulation.

TABLE 8. Average percentage of defoliation for 3 replications of each treatment after various exposure times.

Material tested	Average percent defoliation		
	3 hours	7 hours	19 hours
Coax (1.0 lbs/acre)	12	27	87
Coax (100%/gal/acre)	37	55	100
ABG-7022	11	18	47
ABG-7022	8	22	72
Dipel 8L - 16 BIU/gallon/acre	9	16	43
Dipel 8AF - 16 BIU/gallon/acre	4	4	8
Foray - 16 BIU/gallon/acre	10	10	10
Thuricide 32LV - 16 BIU/gallon/acre	3	4	8
Condor OF - 16 BIU/gallon/acre	9	9	12
Control - untreated	18	40	73

A second test consisted of 10 replications and test insects were given a choice of what treated diet they preferred to feed on. A treated and untreated control were placed in each dish with 3 newly moulted 2nd instar gypsy moth larvae for 24 hours.

TABLE 9. Average percentage of defoliation for 10 replications of each treatment after 24 hours

Material tested	Average percent defoliation	
	Treatment	Control
Coax (1.0 lbs/acre) -- Control untreated	45	11
Coax (100%/gal/acre) -- Control untreated	40	15
ABG-7022 No Emul -- Control untreated	8	19
ABG-7022 Emul -- Control untreated	11	45
Dipel 8L - 16 BIU/gal/acre -- Control untreated	2	31
Dipel 8AF - 16 BIU/gal/acre -- Control untreated	1	8
Condor OF - 16 BIU/gal/acre -- Control untreated	5	7
Thuricide 32LV - 16 BIU/gal/acre -- Control untreated	1	2
Foray 48B - 16 BIU/gal/acre -- Control untreated	2	4
Control untreated -- Control untreated	11	26

A number of stickers were tested with an experimental formulation of gypsy moth pheromone. RA 1990, Rhoplex B60A, Gelva 2397 and Bond were the most effective stickers when used with Agri-Sense Beads. An experimental field test was conducted in 1990 with the beads and RA 1990 sticker.

Field

Field tests were held in Pennsylvania, North Carolina, West Virginia, Tennessee and Virginia during 1990. All treatments were made by Animal and Plant Health Inspection Service pilots and aircraft from their aircraft operation center, Moore Air Base, Mission, Texas. We thank them for their continued support of Science and Technology's activities.

In Pennsylvania, 10 experimental formulations were tested on field plots (50 acres each) and one used as a pilot study (500 > acres).

TABLE 10.

MATERIALS FIELD TESTED IN 1990 - APHIS, S&T

Margosan-O	4 oz/128 oz/acre
Margosan-O	16 oz/128 oz/acre
Dimilin 25W	.03 lbs. AI/128 oz/acre
Dimilin 2F (special)	.03 lbs. AI/32 oz/acre
Dimilin 2F (special)	.03 lbs. AI/16 oz/acre
Dipel 8L + ABG 7022	20 BIU/80 oz/acre
Dipel 8L + ABG 7022	10 BIU/40 oz/acre
Dipel 8L + oil	20 BIU/80 oz/acre
Dipel 8AF + water	20 BIU/80 oz/acre
Dipel W/P + ABG 7022	20 BIU/80 oz/acre
Dipel W/P + ABG 7022	10 BIU/40 oz/acre

All applications were made with a Cessna Ag-truck aircraft equipped with conventional spray boom and flat fan spray tips. All larvae were early 2nd instar and foliage was approximately 30 percent expanded at time of treatment. All treatments except three were replicated four times.

Treatment evaluation consisted of pre- and post-spray egg mass counts; larvae under burlap counts, defoliation estimates, aerial evaluation of defoliation and a general observation rating.

For the 3rd year, low volume applications of Dimilin 2F (Special) were tested and compared to a standard Dimilin 25W treatment. Dimilin 2F (Special) was pilot tested at 0.03 lbs. AI/32 oz./acre. Gypsy moth egg mass counts averaged 8,775 per acre and there was approximately 10 percent defoliation at the time of treatment.

A general population collapse occurred in all spray and control plots. However, based on defoliation estimates and general observations (ratings), the low volume applications were as effective as the standard Dimilin 25W treatments. The 500 acre pilot study plot (0.03 lbs. AI/32 oz./acre) looked excellent. There was no obvious difference between the pint and quart treatments.

TABLE 11.

FIELD STUDIES WITH DIMILIN IN 1990 - APHIS

FORMUL.	DOSAGE/RATE (lbs.AI/_oz/A)	% DEFOL.	RATING	POP. CHANGE
25W	.03/128 oz.	21	8	- 99.7
2F (SP)	.03/32 oz.	15	8	-100
2F (SP)	.03/16 oz.	23	8	- 99.9
CONTROL		50	3	- 94 + 12 13

TABLE 12.

LOW VOLUME DIMILIN STUDIES 1988 - 1990 APHIS

FORMUL.	DOSAGE/RATE (lbs.AI/ oz/A)	% DEFOL.	POP. CHANGE
2F (SP) 1988	.03/32 oz.	<5	- 99
2F (SP) 1989	.03/32 oz.	5	- 99
2F (SP) 1990	.03/32 oz.	15	-100
2F (SP) 1988	.03/16 oz.	<5	- 94
2F (SP) 1989	.03/16 oz.	5	- 99
2F (SP) 1990	.03/16 oz.	23	- 99.9
25W 1988	.03/128 oz.	<5	- 95
25W 1989	.03/128 oz.	5	- 98
25W 1990	.03/128 oz.	21	- 99.7

TABLE 13.

LOW VOLUME DIMILIN STUDIES 1988 - 1990 APHIS

FORMUL.	DOSAGE/RATE (lbs.AI/_oz/A)	% DEFOL.	POP. CHANGE
	1988		
25W	.03/128 oz.	<5	- 95
2F (SP)	.03/64 oz.	<5	- 99
2F (SP)	.03/32 oz.	<5	- 99
2F (SP)	.03/16 oz.	<5	- 94
CONTROL		11	+511
	1989		
25W	.03/128 oz.	5	- 98
25W	.015/128 oz.	5	- 98
2F (SP)	.03/32 oz.	5	- 99
2F (SP)	.015/32 oz.	5	-100
2F (SP)	.03/16 oz.	5	- 99
CONTROL		25	- 31
	1990		
25W	.03/128 oz.	21	- 99.7
2F (SP)	.03/32 oz.	15	-100
2F (SP)	.03/16 oz.	23	- 99.9
CONTROL		50	- 94

Based on these data and the fact that Dimilin 4F is now registered, 0.03 lbs. AI/32 oz./acre treatments of Dimilin 4F (Special) should be available for limited operational use in 1991. A pilot study (500 > acres) should be conducted with Dimilin 4F (Special) at 0.03 lbs. AI/16 oz./acre in 1991. Rates of 8 and 12 ounces per acre should be tested on 50 acre field plots in 1991.

Margosan-O, a neem formulation, was field tested (50 acre plots) at 4 and 16 ounces of formulation in 128 ounces of water per acre. Three percent Triton 1956 sticker was used in the formulation. All mixing was done in the aircraft. Average egg masses were 3,923 per acre.

Although some foliage protection was achieved, results were generally poor based on our general observation rating. Poor results may have been due to ultraviolet light degradation and/or washoff. Triton 1956 gives limited protection from washoff, however, no rain occurred on treated plots until 2.5 days following treatment. The effects of UV light on Margosan-O have not been investigated.

Additional laboratory work will be done with Margosan-O in an attempt to determine why it did not perform more efficaciously in the field. Other stickers will be tested so a more effective one may be available for use with this product.

TABLE 14.

FIELD STUDIES WITH MARGOSAN-O IN 1990 - APHIS

FORMUL.	DOSAGE/RATE	% DEFOL.	RATING	POP. CHANGE
S/C	16 oz/128 oz/A	27	5	-93
S/C	4 oz/128 oz/A	31	5	-92
CONTROL				-94

An experimental carrier (ABG-7022) was tested in the field with Dipel 8L and Dipel technical powder. Treatments were compared to Dipel 8AF and Dipel 8L with oil.

Laboratory test results using this carrier with a number of Bt formulations were outstanding. However, field test results were no better than those with Dipel 8AF and only slightly better than with Dipel 8L and oil. The plots treated with Dipel technical powder and ABG-7022 appeared to have the best control based on defoliation and general observations. Overall there was little difference between any of the treatments.

Over the past two years, there has been a shift to nearly all aqueous Bt formulations for use against gypsy moth. Therefore, it is not necessary to continue work with oil formulations of Bt for gypsy moth control. However, ABG-7022 can be used with aqueous Bt material. Field testing should continue with ABG-7022 (Emul) and aquacious Bt formulations. Tests should be in areas where the gypsy moth population is healthy and building with maximum egg mass counts of 1,000 per acre. In 1990, egg mass counts averaged 5,835 per acre in Bt treatment plots.

TABLE 15.

FIELD STUDIES WITH *BACILLUS THURINGIENSIS* BT IN 1990 - APHIS

FORMULATION	DOSAGE/RATE (BIU/oz/A)	LARVAE	DEFOL.	RATING	CHANGE
Dipel 8L+ ABG 7022	20/80 oz	48	26	7.3	-92
Dipel 8L+ ABG 7022	10/80 oz	94	31	6	-90
Dipel 8L+ oil	20/80 oz	59	30	6.3	-92
Dipel 8AF+ water	20/80 oz	33	27	7.3	-93
Dipel Tech/ P+ABG 7022	20/80 oz	42	24	7.5	-89
Dipel Tech/ P+ABG 7022	10/40 oz	27	15	9	-86
CONTROL		321	50	3	-94

In North Carolina and West Virginia Gypchek was applied to isolated gypsy moth infestations in an attempt to eradicate them. At both locations, two applications were made two days apart with $1x10^{12}$ polyhedral inclusion bodies (PIB) in two gallons per acre. The material was applied with the APHIS Cessna Ag-truck aircraft using 8006 flat fan nozzle tips. All mixing and loading was done by Forest Service personnel (Dr. Podgwaite, Dr. Reardon and H. Hubbard).

The Warren County-Grove Hill site in North Carolina was treated with two applications of Bt in 1989 followed by a four square mile grid trapping program (25 traps/1 sq. mile). In this trapping grid, a moss trapping grid (9 traps/acre) was established and 126 male moths were captured. An extensive egg mass survey turned up two large viable gypsy moth egg masses. The 50> acre treatment area 507 was centered over the egg masses. In 1990 a four mile square grid (25 traps/1 sq. mile) was again used to evaluate the treatment. Trees with burlap were also used to evaluate gypsy moth larvae populations.

No male moths were trapped within the treated area and no larvae were found under burlap. Two male moths were captured within the four square mile grid outside the treatment area. It would appear that this treatment was effective in eliminating gypsy moth larvae from the treatment area.

An isolated infestation of gypsy moth was treated with Gypchek near Athens, West Virginia. Although isolated, this infestation was heavy with egg masses. In a core area of four acres, egg mass counts were approximately 2500 per acre and

moderate defoliation had occurred during 1988 and 1989. No life stages were found outside the generally infested area of 10 to 15 acres.

Approximately 60 acres were treated on May 1st and a second application was applied on May 3rd. Coverage was excellent based on spray card data. Foliage at time of treatment was approximately 10 percent expanded. Although post-spray trapping and egg mass data has not been completely analyzed, larvae counts under burlap and general observations as well as defoliation estimates indicate good control. Some larvae were still present under burlap 6-8 weeks following treatment so eradication was not achieved.

The Gypchek treatment results were encouraging and will result in continued work on isolated infestations in 1991.

Gypsy moth pheromone (Disrupt II) was applied to acreage in Tennessee and Virginia. An experimental formulation of pheromone from Agri-Sense was tested in the field in Virginia. Formulation and application problems were encountered with the Agri-Sense beads resulting in cancellation of most of the scheduled work.

Additional laboratory work will be conducted with the beads and another field experiment will be attempted in 1991.

... found during the Fall 1979 ...

... All block boundaries ...

... 1980 flight period. All ...

... catches were placed within ...

... single catches were ...

... Bacillus thuringiensis ...

... Each spray block (Table ...

... Aerial application was made using ...

... Bell 206B3's. All aircraft ...

... Fairchild aircraft ... calibrated ...

... Forty ... at 24 BIU's was applied ...

Application costs, which includes the cost of ...

... per acre. Total project costs ...

... acres treated ...

... trapping was conducted within residential ...

Approximately 2200 traps were placed within these residential ...

... estimates of the cost of trap placement and retrieval ...

... $5.00 per trap.

... by APHIS personnel ...

... 160 detection traps were ...

No moths were captured in the detection ...

... were placed in the ...

... three blocks. Of these, ... traps were ...

... This represents an increase of ...

... survey of this type ...

... were listed ...

... additional traps ...

... traps retrieved ...

... to 2,239 ...

... Four County ...

...
... days each.

UTAH GYPSY MOTH ERADICATION PROGRAM

1990 GYPSY MOTH REPORT

STEVE MUNSON
USDA FOREST SERVICE - FOREST PEST MANAGEMENT

Since the gypsy moth was first detected in July 1988, treatment and detection efforts have continued to expand as gypsy moth populations have been discovered in remote areas within the Wasatch mountains of Utah. In May 1989, 1190 acres were treated in the Mt. Olympus Cove area of Salt Lake City. As new populations were discovered during the 1989 detection and delimitation survey, the treatment area expanded in 1990 to include 13 blocks encompassing 20,064 acres in three counties (Davis, Utah and Salt Lake).

1990 Eradication Program

The only egg masses found during the fall 1989 egg mass survey were in the Mt. Olympus Cove spray block. All block boundaries were based on male moths captured during the 1989 flight period. All multiple catches and/or clusters of traps with single catches were placed within 1990 treatment block boundaries. Isolated single catches were often not included in spray block boundaries.

Aerial applications of Bacillus thuringensis, (Bt) were applied over the 20,064 acres in 1990. Each spray block (Table 1) was treated three times at 5-7 day intervals. Aerial application was made using three rotary wing aircraft, one Hiller 12E Soloy and two Bell 206B3's. All aircraft were equipped with four electronic rotary atomizer Beecomist nozzles calibrated to deliver 64 oz. per acre. Foray 48B at 24 BIU's was applied neat for all applications. Application costs, which includes the cost of the Bt and aerial application was $9.23 per acre. Total project costs are approximately 1.1 million which, based on 60,072 acres treated, represents $18.31 per acre.

Mass trapping was conducted within residential sections of each spray block. Approximately 2200 traps were placed within these residential sites. Preliminary estimates of the cost of trap placement and retrieval for mass trapping is $5.06 per trap.

Detection trapping was conducted by APHIS personnel, using the new detection trapping guidelines developed by APHIS, 169 detection traps were placed throughout the state. No moths were captured in the detection survey.

Approximately 6,000 traps were placed in the delimitation survey within and surrounding the 1990 spray blocks. Of these, 2,000 traps were place on Forest Service land in mountainous terrain. This represents an increase of 1,500 traps compared to the 1989 delimitation survey in this type of terrain. Only 5 percent of the traps placed in the mountains were listed as missing in 1990, compared to 30 percent listed as not found in 1989. In 1990, 527 moths were caught in the delimitation traps. Of these, 286 moths were captured outside of the treatment blocks. Most of the increase is due to additional traps placed in remote terrain and the high percentage of traps retrieved. Within the treatment blocks only 241 moths were captured compared to 2,239 positive catches in 1989 (Table 2).

In 1991, 14 blocks totaling 29,925 acres will be treated in a four county area (Davis, Salt Lake, Utah and Summit) of northern Utah (Table 3). B.t. at 24 BIU's will be applied neet in 3 applications spaced 5-7 days apart.

Table 1. 1990 Spray Block Acreage

Block #	Non-Federal	Federal		Total Federal	Total Block
		Forest	Wilderness		
DA1	5045	2317	0	2317	7362
SL1	1936	1124	483	1607	3543
SL2	72	0	0	0	72
SL3	102	79	0	79	181
SL4	966	320	0	320	1286
SL5	41	10	0	10	51
SL6	0	0	287	287	287
SL7	6	95	18	113	119
SL8	82	29	164	193	275
SL9	478	148	0	148	626
SL10	167	328	60	388	555
SL11	213	0	5	5	218
UT1	1803	3686	0	3686	5489
TOTAL	10911	8136	1017	9153	20064

Table 2. Total Number of Male Moths Per Treatment Block.
1989 - 1990

Spray Block Area	1989	1990	Percent
SL1 - Millcreek	490	199	60
SL2 - Mt. Aire	6	0	100
SL3 - Lambs Canyon	9	0	100
SL4 - Hatch Canyon	10	0	100
SL5 - Little Mtn.	5	0	100
SL6 - Tolcat	9	3	66
SL7 - Lower Big Ctn.	7	0	100
SL8 - Upper Big Ctn.	6	0	100
SL9 - Top of the World	66	12	81
SL10 - Little Ctn.	20	3	85
SL11 - Bells Canyon	7	0	100
DA1 - Bountiful	703	15	98
UT1 - Provo	901	9	99
Total	2,239	241	90

Table 3. 1991 Spray Block Acreage

Block #	Block Name	Acres by Ownership		Total
		Federal	State/Private	Acres/Block
DA1	Parrish Creek	2950	539	3489
DA2	Mueller Park	2842	1851	4693
SL1	Red Butte	989	217	1206
SL2	Burr Fork	6	166	172
SL3	Alexander Creek	440	1640	2080
SL4	Mt. Dell	63	362	425
SL5	MillCreek	4200	1788	5988
SL6	Heughs Canyon	389	233	622
SL7	Knudsens Corner	0	72	72
SL8	Deaf Smith	1313	806	2119
SU1	Big Bear Hollow	0	507	507
UT1	Vivian Park	2479	2860	5339
UT2	Hope Campground	1205	1107	2312
UT3	Squaw Peak	811	90	901
TOTAL		17,687	12,238	29,925

STATE OF IDAHO

SUMMARY REPORT OF 1990
GYPSY MOTH
ERADICATION AND SURVEY EFFORTS

with a brief history
of gypsy moth related activities
from 1974 to 1989

by

R. LADD LIVINGSTON

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P.O. Box 670
Coeur d'Alene, ID
83814-0670

REPORT: IDL 90-7
October 1990

STATE OF IDAHO

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GYPSY MOTH
ERADICATION AND SURVEY EFFORTS

ERADICATION PROJECT

AERIAL SPRAY WITH Bt

The Idaho Department of Lands with cooperation from the USDA Forest Service and the USDA-Animal and Plant Health Inspection Service implemented plans to eradicate the gypsy moth, *Lymantria dispar* L. from two areas in north Idaho. Approximately 1060 acres were treated with Foray 48B™, *Bacillus thuringiensis* (Bt) insecticide. This was the pesticide of choice due to the narrow range of target insects, lack of general impact on the environment and acceptance by the public. The spray was a 1:1 dilution of Foray to water. The application rate was three quarts (96 oz.) mixture per acre which gave a final delivery of 18 BIUs Bt per acre.

Coeur d'Alene, Kootenai Co., had one urban spray block of 25 acres while Sandpoint, Bonner Co., had 2 urban spray blocks of 10 and 25 acres and a rural block of 1000 acres. Each site received three aerial applications of Bt at 7 to 10 day intervals. Spraying began on May 9, and ended on June 6, 1990.

The spray aircraft was a Hiller-Soloy 12E single-rotor, turbine-engine helicopter with a 140-gallon tank. The spray boom was 33 feet long with six Beacomist Model 360A electronic rotary atomizer nozzles. The three nozzles on each side of the boom were spaced 21 inches apart with the inside nozzle 4.5 feet from the center of the aircraft.

We did not have a large enough larval population to measure pre and post spray densities so our measurement of success was in the pheromone mass trapping effort.

MASS TRAPPING

A mass trapping program covering the aerial treatment areas was implemented as a follow-up to the insecticide treatment using a density of 9 traps per acre in the urban sites of both Coeur

d'Alene and Sandpoint, and 5 per acre in the rural setting. A total of 3268 traps were used in this effort.

RESULTS

NO MOTHS WERE CAUGHT IN ANY OF THE TREATED AREAS IN 1990.

PHEROMONE SURVEYS

DETECTION SURVEY

The state wide detection survey was conducted by the Idaho Department of Lands, the Idaho Department of Agriculture, and the USDA Forest Service, Regions 4 and 1. Traps, pheromone baits and cost share funding were provided by APHIS, PPQ.

The Idaho detection survey is divided into three geographical regions of responsibility: northern Idaho covered by the Idaho Department of Lands, southwestern Idaho covered by the Idaho Department of Agriculture, and southeastern Idaho covered by the USDA Forest Service Region 4, Boise Field Office. The Forest Service Region 1, Forest Pest Management office Coeur d'Alene placed traps in NFS campgrounds in northern Idaho.

All detection trapping is done at a minimum trap density of 4 per square mile. The traps are checked twice during the peak of the flight season so that we can put out delineation traps that same season if moths are found.

In each of the three geographical survey regions the work is further subdivided into towns and cities or rural areas that are trapped on three different schedules. Priority 1 areas are trapped every year. These include those cities where gypsy moths have been found, or those with universities, military bases, government installations, or significant industry where we anticipate a high number of families moving in each year. Priority 2 and 3 areas, which are determined by population size, are surveyed every other year or every third year, respectively. Since many people that move into Idaho choose rural areas in which to live, we also survey these sites on a schedule that corresponds to that of the closest city or town. We also monitor the number of families moving into Idaho from gypsy moth infested states and if a city or area reaches a threshold in a year's time we will conduct a survey the next trapping season regardless of the original schedule.

DETECTION RESULTS

In 1990 a total of 5640 detection traps were placed, 4493 in North Idaho, 614 in South West Idaho and 533 in South East Idaho. A total of 4 gypsy moths were found in these traps; 1 in a KOA campground in Idaho Falls (SE Idaho), and 3 in a single trap in the small town of Dover (N Idaho), approximately 1.5 miles south of the large rural aerial spray block near Sandpoint.

DELINEATION SURVEY

The delineation trapping, which is conducted by the Idaho Department of Lands, is done at a minimum of 36 traps per square mile. In 1990 five areas were trapped at the delineation density using a total of 358 traps. These sites were: In southeastern Idaho, portions of Idaho Falls (157 traps) and Pocatello (100 traps) where moths were found in the 1989 detection survey; in northern Idaho adjacent to the urban spray areas of Coeur d'Alene (12 traps) and Sandpoint (16 traps), and surrounding the spot in Dover (73 traps) where the three moths were found during the flight season in a 1990 detection trap.

DELINEATION RESULTS

Two moths were found in the delineation survey. These were in Idaho Falls in the center of the area where six moths were found in 1989.

FUNDING

This project was funded by the Idaho Department of Lands with cooperative cost share suppression funds being provided by the USDA Forest Service, Region 1, and the USDA-Animal and Plant Health Inspection Service. Cost per acre for the contract spraying was $89.28/acre and $26.20/acre for mass trapping.

PUBLIC INFORMATION

An information effort was conducted to inform and educate the public about the pest, the need to control it, the pesticide to be used and to ask for input relative to the project proposal. An environmental assessment was prepared and distributed to many individuals, local, state and federal agencies and to environmental and other interest groups for comment. Public meetings were held in Coeur d'Alene and Sandpoint. Overall consensus was favorable for the spray project.

Numerous articles appeared in local newspapers throughout the time of the entire program. Presentations were also given to the County Commissioners for both Kootenai and Bonner counties. A toxicology profile for the Bt pesticide used was sent with a cover letter explaining the project to all physicians in both Coeur d'Alene and Sandpoint.

Fliers announcing the first aerial application of insecticide were distributed to residents within the project areas the evening prior to the first treatment. Also, phone calls were made prior to each treatment to individuals who had expressed special concerns or needs.

DISCUSSION

We feel the spray project and the mass trapping were successful. We have not yet looked for egg masses in Dover and Idaho Falls where the moths were found in the detection or delineation surveys. However, the results of this effort will help determine the need for spraying next year. The minimum control effort in 1991 is anticipated to be mass trapping around the two sites.

A BRIEF HISTORY OF GYPSY MOTH and RELATED ACTIVITIES IN IDAHO FROM 1974 to 1989

1974 - 1985

Detection trapping in Idaho started in 1974 when the Idaho Department of Lands placed traps in all of the rest stops, campgrounds, state parks and tourist attraction sites throughout the state. This effort continued through 1983 when it was turned over to the Idaho Department of Agriculture with limited participation by the Idaho Department of Lands.

1986-1987

In 1986 the responsibility for the state-wide program was returned to the Idaho Department of Lands.

The gypsy moth was first detected in Idaho in 1986 when one male moth was caught in a pheromone-baited survey trap at Sandpoint. In 1987, 35 moths were caught, 22 at Sandpoint, 11 at Coeur-d'Alene, and one each at Lewiston and Cascade.

1988

In the spring of 1988 an egg mass survey was conducted (eggs deposited in 1987) with 1,440 residential properties being searched in Coeur d'Alene and 1,170 in Sandpoint. Forty-four egg masses were found in Sandpoint and three in Coeur d'Alene. A total of 4 properties in Coeur d'Alene and 21 in Sandpoint were found to have evidence of various gypsy moth lifestages.

In an effort to reduce the population as much as possible, a ground spray program was initiated in May of 1988. Orthene, an organic phosphorus insecticide, was used on ornamental trees, and Dipel a biological insecticide containing the bacterium *Bacillus thuringiensis*, Bt, was applied to fruit trees. A total of 23 trees in Coeur d'Alene and 68 trees in Sandpoint were treated. Each tree was sprayed three times.

Summer 1988 pheromone trap and fall egg mass surveys revealed that the gypsy moth was still present in both towns. In Coeur d'Alene

87 male moths were caught and 2 egg masses located. In Sandpoint 334 male moths were caught and 32 egg masses located. A direct comparison of pheromone trap catches between 1987 and 1988 cannot be made as a grid system of trap placement covering all of the infested area was used for the first time in 1988. This was also the first year that the grid system was used for the detection trapping in urban areas throughout the state.

1989

In a fall 1988 evaluation of the gypsy moth situation, it was the consensus of the Idaho Department of Lands, the USDA Forest Service, the USDA-Animal and Plant Health Inspection Service, and the Idaho Department of Agriculture that the gypsy moth was established in Sandpoint and Coeur d'Alene and that an eradication effort should be initiated in 1989.

In preparation for this project, an environmental assessment was prepared addressing several options, public meetings were held, news releases and general information was provided to newspapers and radio and television stations of the area, and general information covering the gypsy moth and announcements for the public meetings were hand-delivered or sent to all residents within the proposed treatment areas.

After reviewing the situation and receiving public comment, the Idaho Board of Land Commissioners on May 1, 1989, authorized implementation of plans to eradicate the gypsy moth from Idaho.

The 1989 treatments included three aerial applications of Dipel 8L, a biological insecticide with Bacillus thuringiensis (Bt) to 110 acres in Coeur d'Alene, and to 270 acres in Sandpoint, and implementation of a mass trapping program as a follow-up to the insecticide treatment. Intensive egg mass surveys were also conducted in areas where multiple pheromone-baited moth catches occurred.

In 1989 a total of 68 moths were caught in the mass trapping and detection\delineation survey traps.

In the **mass trapping** effort, 1,343 traps were placed in Coeur d' Alene covering approximately 150 acres, and 5,907 traps were placed in Sandpoint covering approximately 655 acres. A total of 28 male moths were caught in Coeur d'Alene. Two small infestation areas were delineated. In Sandpoint 23 male moths were caught, again in two pockets.

Based on the positive pheromone trap catches, two locations in

Coeur d' Alene and two in Sandpoint were surveyed for egg masses. In Coeur d' Alene two egg masses were found on a single property. In Sandpoint five egg masses were found. Four of these were found in one area; three on a single tree, and the fourth on an adjacent property.

In **detection\delineation surveys** conducted throughout the state in 1989, 17 other moths were caught, six in Idaho Falls, 1 in Pocatello, four in Coeur d'Alene and six in Sandpoint.

Table I SURVEYS

PHEROMONE TRAPPING (Number caught)

Detection/ Delineation trapping

	1974-85	1986	1987	1988	1989	1990
Coeur d'Alene			11	87	4	
Sandpoint		1	22	334	6	
Other			2		7	6
TOTALS	0	1	35	421	17	6

Mass Trapping

	1974-85	1986	1987	1988	1989	1990
Coeur d'Alene					28	0
Sandpoint					23	0
TOTALS	NA	NA	NA	NA	51	0
TOTAL MOTHS CAUGHT	0	1	35	421*	68	6

EGG MASS SURVEY (Numbers found)

	1986	1987	1988	1989	1990
Coeur d'Alene		3	2	2	
Sandpoint		44	32	5	
TOTAL	NA	47	34	7	**

* Grid trapping initiated
* * Survey yet to be conducted

Table II TREATMENT ACREAGES

	1988	1989	1990
SPRAY	ground spray Orthene/Dipel	aerial spray Dipel 8L 3 times	aerial spray Foray 48B 3 times
Coeur d'Alene	23 trees 4 properties	110 acres	25 acres
Sandpoint	68 trees 19 properties	270 acres	1035 acres
TOTALS	91 trees 25 properties	380 acres	1060 acres
MASS TRAPPING		9 traps per acre	9 or 5 traps per acre
Coeur d'Alene		150 acres 1343 traps	25 acres 225 traps
Sandpoint		655 acres 5907 traps	1060 acres 3043 traps
TOTALS		805 acres 7250 traps	1060 acres 3268 traps
	NA	805 acres	1060 acres

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R. LADD LIVINGSTON

Idaho Department of Lands
P.O. Box 670
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1989

In a fall 1988 evaluation of the gypsy moth situation, it was the consensus of the Idaho Department of Lands, the USDA Forest Service, the USDA-Animal and Plant Health Inspection Service, and the Idaho Department of Agriculture that the gypsy moth was established in Sandpoint and Coeur d'Alene and that an eradication effort should be initiated in 1989.

In preparation for this project, an environmental assessment was prepared addressing several options, public meetings were held, news releases and general information was provided to newspapers and radio and television stations of the area, and general information covering the gypsy moth and announcements for the public meetings were hand-delivered or sent to all residents within the proposed treatment areas.

After reviewing the situation and receiving public comment, the Idaho Board of Land Commissioners on May 1, 1989, authorized implementation of plans to eradicate the gypsy moth from Idaho.

The 1989 treatments included three aerial applications of Dipel 8L, a biological insecticide with Bacillus thuringiensis (Bt), and implementation of a mass trapping program as a follow-up to the insecticide treatment. Intensive egg mass surveys were also conducted in areas where multiple pheromone-baited moth catches occurred.

In 1989 a total of 68 moths were caught in the mass trapping and detection\delineation survey traps.

In the **mass trapping** effort, 1,343 traps were placed in Coeur d' Alene covering approximately 150 acres, and 5,907 traps were placed in Sandpoint covering approximately 655 acres. A total of 28 male moths were caught in Coeur d'Alene. Two small infestation areas were delineated. In Sandpoint 23 male moths were caught, again in two pockets.

Based on the positive pheromone trap catches, two locations in Coeur d' Alene and two in Sandpoint were surveyed for egg masses. In Coeur d' Alene two egg masses were found on a single property. In Sandpoint five egg masses were found. Four of these were found in one area; three on a single tree, and the fourth on an adjacent property.

In **detection\delineation surveys** conducted throughout the state in 1989, 17 other moths were caught, six in Idaho Falls, 1 in Pocatello, four in Coeur d'Alene and six in Sandpoint.

Gypsy Moth Survey and Detection Programs - 1990

Oregon Department of Agriculture

Status at the end of the 1989 Survey Season:

In 1989, approximately 22,250 gypsy moths traps were placed statewide. Only two gypsy moths were detected, about three miles apart in Eugene, Lane Co. This was the fewest caught in the state since 1979, the year gypsy moths were first detected in Oregon. No gypsy moths were caught in Lake Oswego, Clackamas Co., the only site receiving eradicative sprays (B.t.) in 1989. For the first time since 1980, no eradication programs were planned for the following spring in 1990.

1990 Survey Program:

Nineteen gypsy moths were detected in Oregon in 1990 (Table 1). All detections were in western Oregon; only two traps had multiple catches. Detections were made in nine general areas from north to south as follows: Warrenton (two moths in one trap); Hillsboro (one moth in one trap); West Portland (two single moths in two traps); Lake Oswego (four moths in one trap, plus four scattered singles); Estacada (one moth in one trap); Eugene (two single moths in two traps); Rogue River (two single moths in two traps); and Cave Junction (one moth in one trap).

The two gypsy moths in Eugene were caught about a mile southwest of each of the two single detections made there in 1989. This is down from over 19,000 moths detected in Lane Co. in 1984 and reflects the success of the earlier eradication projects in combination with the detection and delimitation trapping programs. About 6,000 traps were placed in Lane Co. this year. The multiple detection in Lake Oswego (four moths) is about 1/3 mile northeast of the 1989 eradication area. This is likely to be a new introduction site as several move-ins from the northeast have already been identified in the immediate area.

As in previous years, gypsy moth survey and detection traps were concentrated in western Oregon, where most of the sũitable habitat and population centers occur. The standard detection trap density was 1-4 traps/mi^2. Delimitation trap densities of 16-49 traps /mi^2 were placed at all 1989 detection sites, and were used to monitor previous eradication areas. No mass trapping was done in 1990. Special sites such as state and national parks, public and private campgrounds, and RV parks were also trapped.

Approximately 16,335 traps were placed statewide as follows: 11,680 detection traps, 3,755 delimitation traps, and 900 additional delimitation traps added in response to new gypsy moth detections.

Projected Eradication and Survey Programs in 1991:

Information gathering regarding recent move-ins from the northeastern U.S. and subsequent egg mass searching are planned at up to five sites where new detections were made: Warrenton, Lake Oswego, Estacada, Rogue River, and Cave Junction. Any eradication programs for 1991 will be based on the results of egg mass searching and detection data in those areas. Eradication programs would likely be less than 640 acres, and use *Bacillus thuringiensis* applied from the ground if possible. Since most of Lane County has been free of gypsy moths for four years, a reduced trapping program is projected for 1991. Delimitation trapping around all 1990 gypsy moth detections, and any eradication sites will supplement our usual survey program.

Table 1. Summary of 1990 Gypsy Moth Detections in Oregon.

County	City/Area	Total Males Caught	Trap Density
Clackamas	Estacada	1	1/mi^2 (increased)
	Lake Oswego	8	16/mi^2 (increased)
Clatsop	Warrenton	2	2/mi^2 (increased)
Jackson	Rogue River	2	1/mi^2 (increased)
Josephine	Cave Junction	1	1/mi^2 (increased)
Lane	Eugene	2	16-49/mi^2 (increased)
Washington	Hillsboro	1	4/mi^2
	Raleigh Hills, W. Portland	1	4/mi^2 (increased)
	Sylvan Hills, W. Portland	1	4/mi^2 (increased)

Statewide total = 19

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COLORADO STATE FOREST SERVICE REPORT TO:
WESTERN REGIONAL GYPSY MOTH MEETING
SALT LAKE CITY, UTAH
NOVEMBER 7-8, 1990

Colorado detected its first gypsy moth in 1984. Through 1989, gypsy moths had been detected in 12 separate locations, mostly along the Front Range urbanized corridor. Positive traps in 1989 indicated that going into the 1990 season Colorado potentially had four active gypsy moth populations.

The potential 1990 infestations in Limon, Colorado Springs (Upper Skyway neighborhood) and Rosita were delimitation trapped (25 traps per square mile). To date these areas have produced 0 moths in 1990. All traps have been retrieved, with the exception of 25 in Colorado Springs.

The "East" Fort Collins population (7 acres) was treated May 17 and May 30 with ground-applied Bt (Dipel, at the equivalent of 20 BIU's per acre). A total of 28 properties were involved. This general area was also mass trapped (9 traps per acre) and surrounded by a "halo" of delimitation traps. This area produced 0 moths in 1990.

The "West" Fort Collins infestation area (first year of 0 moths was 1989) was delimitation trapped and produced a second consecutive year of 0 moths. This area is now considered eradicated.

In addition, 2358 detection traps were placed statewide. All 63 Colorado counties received coverage. As of this date, all but 41 traps have been retrieved. No gypsy moths have been found in detection traps in 1990.

In summary, for the first year since 1984, Colorado has produced no gypsy moths in traps. All traps have been retrieved with the exception of traps located in the Nucla, Ouray, Gunnison and Alamosa areas.

The following infestation or positive-catch areas are now considered eradicated: Rocky Mountain National Park, Boulder (three areas), "West" Fort Collins, Colorado Springs (Broadmoor), LaPorte (KOA), and Lakewood.

The following areas are considered conditionally eradicated (i.e., one year of 0 catches): Limon, Colorado Springs (Upper Skyway), Rosita, "East" Fort Collins.

PLANS FOR 1991: Efforts will concentrate on detection trapping, with delimitation trapping planned for the above four conditionally eradicated areas.

The Colorado State Forest Service greatly appreciates the help of all our cooperators. In particular we would like to thank: USDA-APHIS (JoAnn Cruse, Helen Lemke, Larry Mohr, Vic Mastro and Chuck Schwalbe); City of Fort Collins (Ralph Zentz and Tim Buchanan); City of Colorado Springs (Joe Billot); City of Boulder (Ellie Bussi); City of Pueblo (Bob Gilliland); National Campers & Hikers Association (Adrian Lindemann); Alpine Tree Service (Gery Whiteman and Monte Deines); US Air Force Academy (Mike Babler); Oregon State Department of Agriculture (Alan Mudge et al); and Washington State Department of Agriculture (Eric LaGasa et al). Any accomplishments achieved to date would not have been possible without their resources, cooperation, shared experience and hard work.

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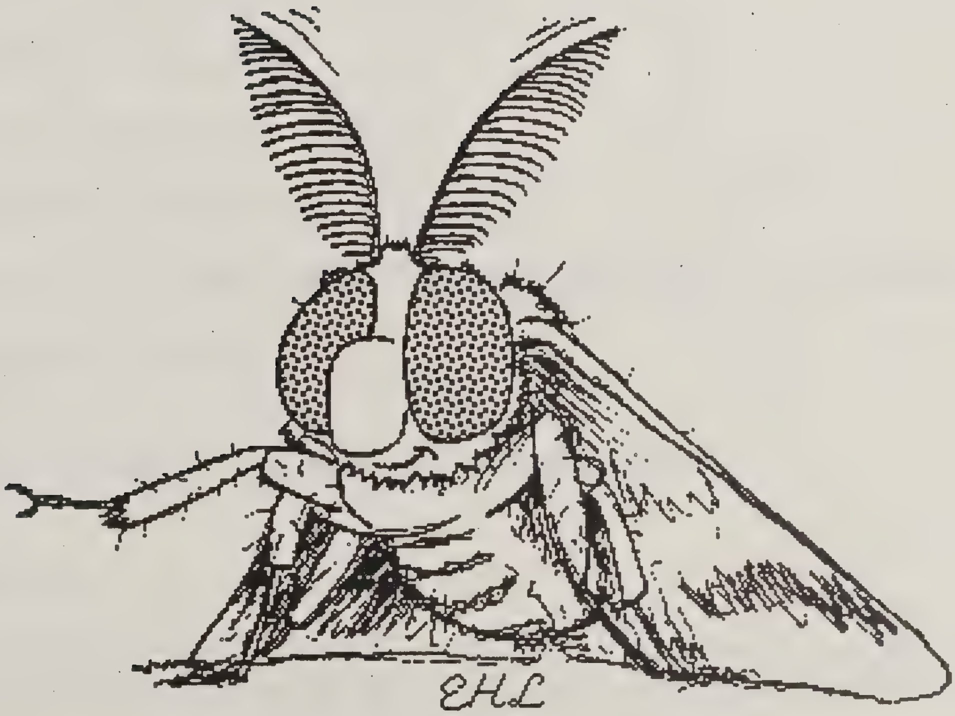
November 5, 1990

Washington State Department of Agriculture
Plant Services Division

1990 GYPSY MOTH PROGRAM SUMMARY REPORT



WSDA - PLANT SERVICES DIVISION
1990 G.M. PROGRAM SUMMARY REPORT

SURVEY & DETECTION:

6889 detection and 1739 delimiting traps were placed for gypsy moth in Washington State in 1990, for a total of 8628 traps.

72 gypsy moths were reported from 46 traps.

Nineteen total catch areas were reported in 1990, up from 13 in 1989. This increase in catch areas, reflecting increased gypsy moth introductions, is the highest since 1983 (see Table I).

Table 1. GM Catch History

	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
# CATCH AREAS	10	14	16	24	13	14	15	17	12	13	19
# TRAPS	~750	~6000	~6000	6224	6299	9208	7329	7484	7706	8471	8628
#MOTHS	212	268	827	1314	161	175	56	39	128	202	72

Thirteen new catch areas were recorded in 1990:

- Clark Co. (Hockinson & Orchards)
- Cowlitz Co. (Longview)
- King Co. (Kent & West Seattle)
- Kitsap Co. (Poulsbo & Port Orchard)
- Snohomish Co. (Marysville, Everett, Brier, Mill Creek & Monroe)
- Stevens Co. (Colville)

Seven 1989 catch areas did not repeat in 1990 (see Table 2).

ERADICATION:

Fifteen moths were caught in the Manor area in 1990 after a two-part aerial application of Bt (Foray 48B at 24 BIU & 1/2 gallon/acre) was applied to 400 acres.

Egg mass searches and possible follow-up spraying will occur at Arlington and Bellingham.

Table 2. 1989 - 1990 W.S.D.A Gypsy Moth Survey Results

County	Catch Area	1989 Total Catch	1989 No. Trap Sites	1990 Total Catch	1990 No. Trap Sites	Control Actions
CLALLAM	Sequim	5	3	0	0	
CLARK	Hockinson	0	0	1	1	
"	Manor	169	90	15	12	(4-'89) (1-'90)
"	Orchards	0	0	1	1	
COWLITZ	Longview	0	0	1	1	
KING	Bellevue	1	1	0	0	
"	Bryne Mawr	1	1	1	1	
"	Issaquah	4	4	4	2	
"	Kent	0	0	1	1	
"	Mercer Island	2	2	0	0	
"	Ravenna	2	2	2	2	
"	West Seattle	0	0	1	1	
KITSAP	Bainbridge Isl.	6	4	0	0	
"	Olalla	3	3	0	0	(2,3-'89)
"	Poulsbo	0	0	3	2	
"	Port Orchard	0	0	9	6	
PIERCE	N. Puyallup	6	5	0	0	
SNOHOMISH	Arlington	1	1	6	1	
"	Marysville	0	0	4	4	
"	Everett	0	0	4	3	
"	Brier	0	0	4	2	
"	Monroe	0	0	1	1	
"	Mill Creek	0	0	1	1	
STEVENS	Colville	0	0	3	1	
THURSTON	Offut Lake	1	1	0	0	
WHATCOM	Bellingham	1	1	10	4	
Totals		**202**	**118**	**72**	**46**	

(1) Aerial Bt
(2) Egg Mass Search (Positive)
(3) Ground Sprays (Orthene)
(4) Mass Trapping (Mating Disruption)
New Site

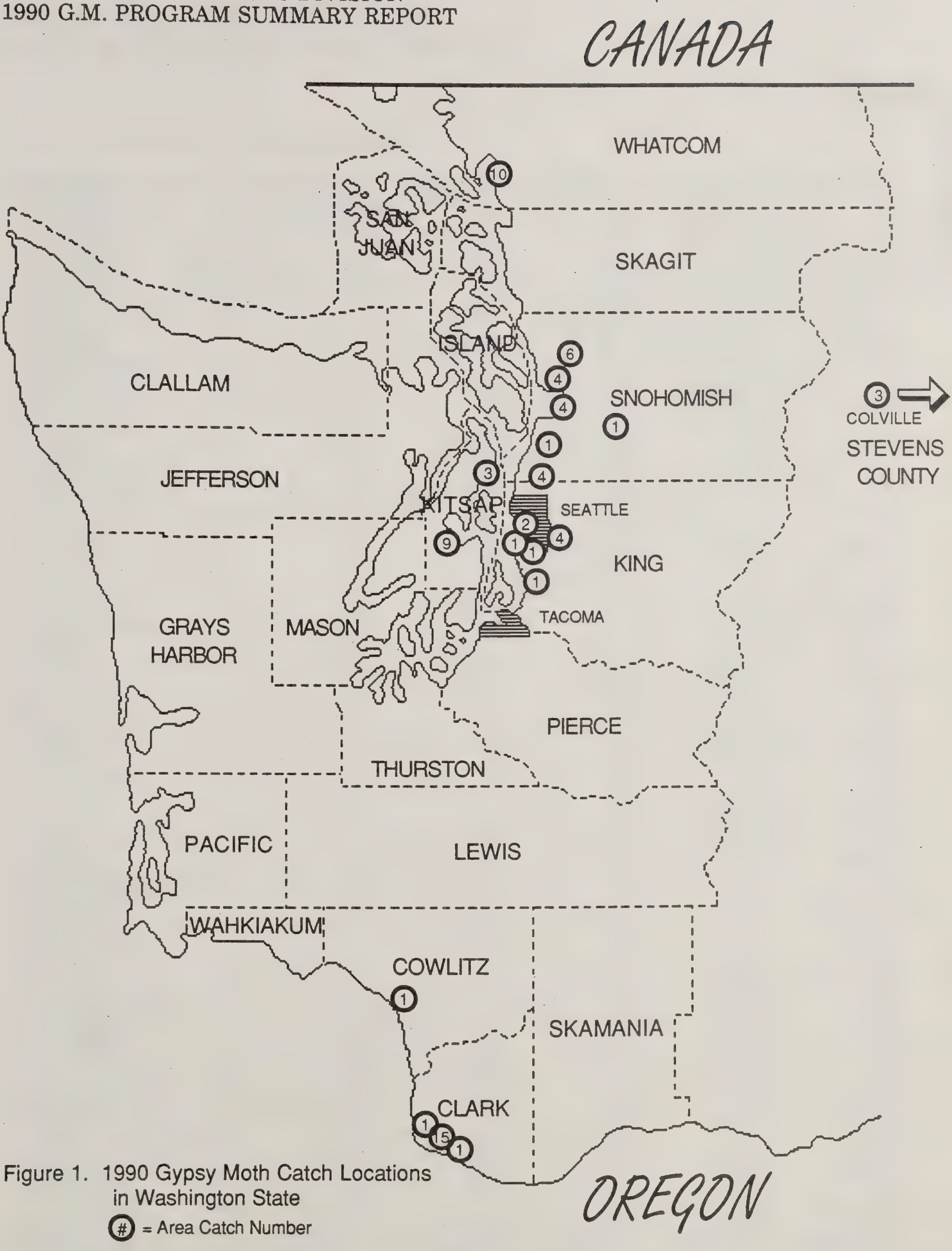


Figure 1. 1990 Gypsy Moth Catch Locations in Washington State
(#) = Area Catch Number

WSDA - PLANT SERVICES DIVISION
1990 G.M. PROGRAM SUMMARY REPORT

Table 3. 1990 G.M. Trap Deployment

COUNTY	9/acre	36/mile	4/mile	1/mile	TOTAL
ADAMS	0	0	0	0	0
ASOTIN	0	0	0	2	2
BENTON	0	0	0	37	37
CHELAN	0	0	0	21	21
CLALLAM	0	56	43	220	319
CLARK	331	175	83	453	1042
COLUMBIA	0	0	0	1	1
COWLITZ	24	0	0	359	383
DOUGLAS	0	0	0	0	0
FERRY	0	0	0	0	0
FRANKLIN	0	0	0	8	8
GARFIELD	0	0	0	1	1
GRANT	0	0	0	0	0
GRAYS HARBOR	0	0	0	401	401
ISLAND	0	0	0	36	36
JEFFERSON	0	0	0	162	162
KING	32	311	107	649	1099
KITSAP	20	143	69	442	674
KITTITAS	0	0	0	27	27
KLICKITAT	0	0	0	53	53
LEWIS	0	0	0	483	483
LINCOLN	0	0	0	0	0
MASON	0	0	0	398	398
OKANOGAN	0	0	0	95	95
PACIFIC	0	0	0	262	262
PEND ORIELLE	0	0	0	8	8
PIERCE	31	39	31 ~~454~~	555	656 ~~555~~
SAN JUAN	0	0	0	91	91
SKAGIT	0	0	0	468	468
SKAMANIA	0	0	0	20	20
SNOHOMISH	0	78	55	370	503
SPOKANE	0	0	0	202	202
STEVENS	0	0	0	70	70
THURSTON	0	25	10	347	382
WAHKIAKUM	0	0	0	109	109
WALLA WALLA	0	0	0	11	11
WHATCOM	0	36	40	540	616
WHITMAN	0	0	0	0	0
YAKIMA	0	0	0	149	149
TOTALS	**438**	**863**	**438**	**6889**	**8628**

Table 4. 1990 Federal Land Gypsy Moth Trap Deployment

FACILITY	TRAPS
Bangor Submarine Base	28
Chehalis Indian Reservation	4
Colville National Forest	5
Fort Lewis	19
Gifford Pinchot National Forest	46
Lummi Indian Reservation	17
McCaw Indian Reservation	2
McChord Air Force Base	11
Mount Rainier National Park	12
Mount Baker-Snoqualmie National Forest	107
North Cascades National Park	48
Okanogan National Forest	37
Olympic National Forest	75
Olympic National Park	35
Port Gamble Indian Reservation	3
Port Madison Indian Reservation	5
Quinault Indian Reservation	3
Skokomish Indian Reservation	3
Swinomish Indian Reservation	13
Tulalip Indian Reservation	19
Wenatchee National Forest	62
Yakima Indian Reservation	9
Total	563

(Federal Trap Numbers are included in Table 3 Totals)

Pennsylvania Gypsy Moth Suppression

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Bureau of Forestry
Office of Resources Management
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... 1990

Pennsylvania Gypsy Moth Suppression Project

1990

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Pennsylvania Gypsy Moth Suppression Project - 1990

Summary

Of the 900,000+ acres of forestland that were originally proposed on October 1, 1989, for treatment in Pennsylvania's 1990 state/federal/county cooperative gypsy moth suppression project, more than 772,000 acres (480,000 private residential, 262,000 State Forest, 28,000 State Park, 1,900 federal, and 449 other) qualified under the Pennsylvania DER program standards. Unfortunately, based upon estimated aerial application costs, available state funds were adequate to treat only about 30 percent of that total. Therefore, in order to keep a roughly equal division between privately and publicly owned acreage, a 75 percent reduction was made in the approved private residential acreage and a 60 percent reduction in the State Forest and State Park acreage. Bids were then solicited on this reduced acreage.

In an effort to contain the ever-increasing costs associated with helicopter-only contracts, five of the six 1990 contracts were opened to either helicopters or fixed-wing aircraft. As a result, the average overall bid price came in at approximately one-half of the projected cost, and we suddenly had a surplus $1.9 million to make available for gypsy moth suppression. Because of the inflexibility of the Commonwealth bidding-and-contract-execution procedures, it was not possible at that time (late January 1990) to rebid and increase the acreage. Therefore, it was decided to make these surplus monies available to cooperating municipalities under the Option II portion of the program's operating procedure. Under this option, the cooperator is responsible for obtaining a contract with an aerial applicator and supervising the spray operation. DER would then cost-share the project at the rate of $12 per acre to cover a portion of the insecticide, application, and overhead costs. A total of 53 municipalities participated under Option II to treat more than 155,800 additional acres for the citizens of Pennsylvania.

Spraying operations for the Option I portion of the 1990 project began on May 6 in District 3 (Cumberland, Franklin, and Perry Counties) and ended on June 2 in District 4 (Somerset County). Overall, a total of 237,319 acres involving 1,400 blocks were treated by the Bureau of Forestry under this option. Of that total, 121,001 acres (1,127 blocks) were treated with <u>Bacillus thuringiensis</u> (Bt) and 116,318 acres (273 blocks) with diflubenzuron (DFB). All of the bureau's 20 forest districts were involved in the operation which took place in portions of 53 of the Commonwealth's 67 counties.

Under the Option II program, DER cost-shared on 154,155 acres treated with Bt and 1,697 acres treated with DFB. All of the Bt acreage except for four acres in Allegheny County, 505 acres in Carbon County, and 176 acres in Monroe County were private residential. The four Bt acres and all of the DFB acreage in Allegheny County involved county parks, while the nonprivate residential Bt acreage in Carbon and Monroe Counties was watershed managed by the Bethlehem Water Authority.

The 1990 spring season was characterized by very warm temperatures in mid-April which brought about a general statewide hatch of gypsy moths during late April. As a result, spraying operations in all parts of the state started at approximately the same time increasing the pressure on the contractors' and the bureau's personnel and equipment. Population density was so heavy in parts of the Commonwealth, especially the eastern, that the larvae were devouring the foliage as quickly as it emerged. In this program our objective is to keep defoliation below 30 percent. However, in many of these areas, the population density was so high that the 30 percent level was exceeded by first-instar larvae before we had a chance to spray. The final straw that may have broken our backs in many areas was the extensive blowing of caterpillars that occurred this year. Cool weather set in after the warm episode in April resulting in prolonged hatch at the higher elevations. The number of larvae and the length of time they were blowing around were greater and longer than any of the old-timers working on the project can remember. It was felt by field personnel that many areas were sufficiently reinfested by blowing larvae after spraying occurred to compromise the effectiveness of the Bt and, in some cases, the DFB sprays.

Details on the overall 1990 cooperative gypsy moth suppression project are given in the following sections.

Acres Treated

Tables 1, 2, 3, 4, and 5 provide information on the insecticide used, number of acres treated, and location of the acreage for each of five ownership categories--private residential, State Forest, State Park, federal, and other--treated under Option I. Table 6 provides the same information for the private residential and other acreage treated under Option II. Table 7 summarizes this information by county for all ownerships but without the insecticide data for both options. Table 8 provides a summation of all acreage treated by ownership and insecticide for both options.

Costs and Contracts

Funding for the cooperative gypsy moth suppression program is provided jointly by the Pennsylvania Department of Environmental Resources, the USDA Forest Service, and the various cooperators involved in the annual project. DER provides the up-front money to support the Bureau of Forestry's involvement in the project, to pay for Option I application and insecticide contracts, and to provide Option II cost-sharing funds. These annual DER funds are made up of a combination of current fiscal year state legislative appropriations and previous year's federal and cooperators' cost-sharing monies. For 1990 the federal cost-share levels are 50 percent for private lands and 25 percent for public lands. County cooperators under Option I were assessed $4 per acre while certain other cooperators (see Tables 4 and 5) were required to pay $14 per acre for Bt treatment and $13 per acre for DFB treatment. While these federal and cooperator funds offset DER's costs for the 1990 project, those monies will not be available for use until the 1991 project. Table 9 provides a summary of the overall costs incurred in the 1990 project and the cost-sharing percentages involved.

Option I Contracts

The 1990 Option I project was divided into six geographical areas as shown on the map below. A separate contract was bid and let for each of these areas with the successful bidders as follows:

Contractor	Contracts
Altair, Inc. Franklin County Airport R. D. 2, Box 279 Swanton, VT 05488 802-868-7951	90-1 90-2 90-4 90-5
Helicopter Applicators, Inc. P. O. Box 810 Frederick, MD 21701 301-663-1330	90-3
K & K Aircraft, Inc. P. O. Box 7 Bridgewater, VA 22812 703-828-6070	90-6

Contract Areas - Option I

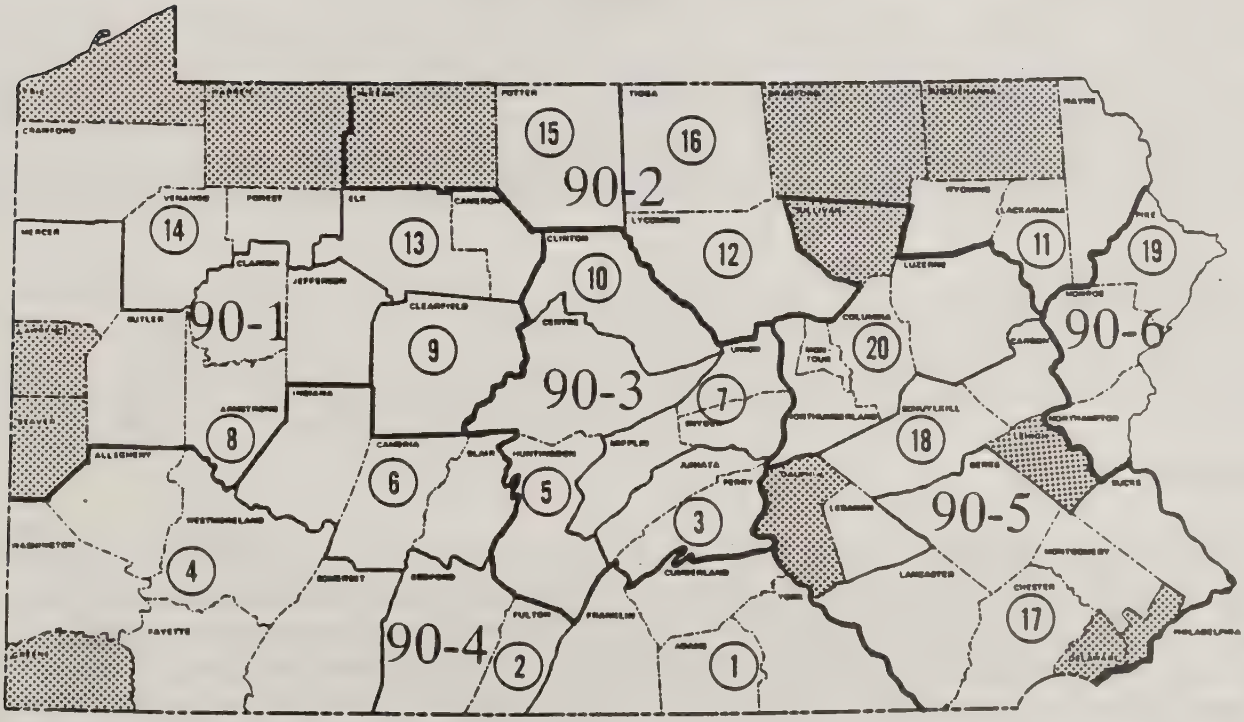


Table 10 provides a breakdown of the cost of insecticide and application for each of the Option I contracts. The "actual cost per acre" is calculated on the actual amount of insecticide applied to treat the designated acreage taking into account any extra material that had to be added because of calibration tolerance, minor acreage calculation discrepancies, or by the necessity to retreat (Bt only) after unexpected heavy rains.

Table 11 is an account of the daily spraying progress for each contract and for the overall project.

Option II Contracts

Table 12 shows the contractor, the contracted price, the spray material, and the rate of application for each of the Option II cooperators. The total cost to the cooperator for the Option II acreage that was cost-shared by DER was $1,936,796.06 or an average of $12.43 per acre. DER cost-shared $1,870,224 of that total.

The addresses and phone numbers for the Option II contractors follow:

Aero Tech, Inc.
Box 517, Highway 60
Bovina, TX 79009
806-238-1331

AgRotors, Inc.
Box 578
Gettysburg, PA 17325
717-334-6777

Altair, Inc.
Franklin County Airport
R. D. 2, Box 279
Swanton, VT 05488
802-524-0164

Appalachian Helicopters, Inc.
Route 1, Box 36D
Ridgway, PA 15853
814-776-1466

Bob Ruhe Ag Service
122 Commercial Street
Leipsic, OH 45856
419-943-3352

Cordoba Helicopter Enterprises, Inc.
R. D. 1, Applegarth Road
Hightstown, NJ 08520
609-448-0031

Evergreen Helicopters, Inc.
3850 Three Mile Lane
McMinnville, OR 97128
503-472-9361

Helicopter Applicators, Inc.
P. O. Box 810
Frederick, MD 21701
301-663-1330

K & K Aircraft, Inc.
P. O. Box 7
Bridgewater, VA 22812
703-828-6070

Insecticides

Two insecticides, *Bacillus thuringiensis* (Bt) and diflubenzuron (DFB), were used on the 1990 project for both Option I and Option II. Three different Bt formulations were used. Condor OF, an oil-based formulation produced by Ecogen, Inc., was applied diluted (one gallon) at 24 BIU per acre to 7,780 (6,280--Option I, 1,500--Option II) acres. An aqueous-based formulation, Dipel 8AF (Abbott Laboratories, Inc.), was used diluted (one gallon) at 16 BIU on 189,274 (98,184--Option I, 91,090--Option II), diluted (three quarts) at 16 BIU on 2,596 (Option I) acres, diluted (one gallon) at 20 BIU on 13,828 (Option II) acres, and diluted (three quarts) at 21 BIU on 1,048 (Option II) acres for a total of 206,746 acres. Another aqueous formulation, Foray 48B (Novo Laboratories, Inc.), was applied to a total of 60,630 acres. Of this total Foray acreage, 29,955 (2,807--Option I, 27,148--Option II) acres were

treated diluted (one gallon) at 16 BIU per acre, 13,333 (Option II) acres were treated diluted (one gallon) at 20 BIU, 6,622 (Option I) acres were treated undiluted (53 ounces) at 20 BIU per acre, 9,317 (3,109--Option I, 6,208--Option II) acres were treated diluted (one gallon) at 24 BIU per acre, and 1,403 (Option I) acres were treated undiluted (80 ounces) at 30 BIU per acre.

The only commercially available formulation of DFB, Dimilin 25W, was used on this project. Of the total 118,015 acres treated with DFB, 116,118 acres in the Option I project were treated with .40 ounce active ingredient (AI) per acre which equals 1.6 ounces of Dimilin 25W. This rate represented a 20 percent reduction from the .50 AI rate used over the past several years. While most of that acreage (105,439) was treated with a final spray volume of one gallon per acre, 10,679 acres were treated with a final spray volume of three quarts per acre applied with rotary atomizers. In an effort to see if the rate of DFB application can be reduced even lower, two 50-acre blocks were treated with .04 ounce AI per acre and two 50-acre blocks were treated with .004 ounce AI per acre at a final spray volume of one gallon per acre. In the Option II project, 1,697 acres were treated with .50 ounce AI (two ounces Dimilin 25W per gallon water) per acre. Information on insecticides used is presented in Table 13.

Aircraft

A total of 21 spray aircraft were used on the 1990 Option I project. Table 14 lists all these aircraft along with information on the pilots and contracts while Table 15 gives calibration information for each of the aircraft. Table 16 provides 1990 production data for each of the spray aircraft, and Table 17 shows the cumulative production data for each model of aircraft. Table 18 provides information on the observation aircraft used by certain districts during the project.

Nine different aerial applicators provided a total of 37 spray aircraft for the 1990 Option II project. Table 19 lists these aircraft along with the pilot's name by contractor. Production data for each aircraft is given in Table 20 and for each model of aircraft in Table 21. Calibration information is not available for the Option II aircraft.

Project Incidents

Several incidents, including two pilot fatalities, which required reporting to the USDA Forest Service and other authorities occurred during the course of the 1990 suppression project. Additional information is available regarding these incidents if needed. The following provides brief synopses of them:

May 7, 1990 - Sixty gallons of mixed Bt were applied off site by an aircraft (Cessna 188 Ag Truck, N731ET) in Northampton County during the course of the Lehigh County Option II project. A downed marker balloon is felt to be the cause of the error. No persons are known to have been impacted.

May 8, 1990 - A spray aircraft (Air Tractor AT-400, N2369N) piloted by Ted Stallings, Aero Tech, Inc., Bovina, Texas, contacted an electric transmission line in Blair County and crashed while treating a Blair County Option II block. Mr. Stallings suffered severe burns and broken bones but survived the crash. The National Transportation Safety Board (NTSB) is investigating the accident and will issue a report.

May 12, 1990 - A portion of State Forest land in District 16, not slated for treatment but contiguous with a scheduled block, was sprayed with DFB when two tandem-flying aircraft (Turbine Thrushes, N7155S and N7155W) missed a cutoff point. The area sprayed was part of a larger area deleted from the original treatment proposal because it contained a wetland community supporting populations of Lycaena epixanthe, a species of concern as contained in the Pennsylvania Natural Diversity Inventory.

May 15, 1990 - An observation aircraft (Cessna 182D, N8757X) crashed en route from the Northumberland County Airport to the Hazleton Municipal Airport to pick up a Bureau of Forestry employee. The pilot, Frank Pavelko, was killed.

May 23, 1990 - A spray aircraft (Grumman Ag-Cat, N913X) working on the Luzerne County Option II project contacted a powerline over the Susquehanna River and crashed. The pilot, Mike Hensel with Downstown Aero Crop Service, Vineland, New Jersey, under subcontract to K & K Aircraft, Inc., Bridgewater, Virginia, was killed.

May 24, 1990 - A spray aircraft (Cessna A-188B Ag Truck, N2200F) showed zero oil pressure while treating a spray block in Luzerne County on the Option I project. Approximately 75 gallons of mixed Bt insecticide were dumped in an isolated, wooded area, and the pilot was able to return to base safely.

May 24, 1990 - Approximately two to four gallons of mixed DFB insecticide were spilled on the airport tarmac at Connellsville Airport, Fayette County, when the aircraft (Bull Thrush, N2239S) began to taxi before the filler hose was removed. Any insecticide that wasn't blown away by the prop blast was hosed off with clean water by the ground crew.

May 25, 1990 - Approximately 25 acres in Bedford County were sprayed off site with mixed Bt insecticide by an aircraft (Grumman Ag-Cat, N7155J) treating acreage on the Option I project. The pilot became confused by marker balloons placed by a private contractor spraying in the same area. The landowners were very happy with the extra treatment.

Program Changes

Landowner Notification

Current procedures require the county cooperators to notify all landowners within approved treatment areas of the impending spraying. This notification must be in writing and must be made by first-class mail or personal service. In an effort to evaluate a less labor-intensive method of meeting this notification requirement, Carbon County was permitted to run legal advertisements (one-half page) in three local newspapers. As a result, the county received hundreds of phone calls requesting additional information and five objections

to spraying. The number of objections is comparable to what is received from first-class mail notification. It is the opinion of the county that this method is less expensive, more effective, and more informative than the letters sent only to landowners within the spray blocks. The procedure will be investigated further for use in future projects.

Posting of State-Owned Land Spray Blocks

In order to advise persons using State Forest and State Park lands of the possibility of spraying while they are on those lands, a warning placard was developed. Forestry and Parks personnel were instructed to place these at trailheads, access roads, picnic areas, and other places within a treatment area where they would be readily noticeable by the public.

Project Evaluation

A separate project was conducted to determine how effective we were in meeting our objectives of keeping defoliation below 30 percent on residential and public lands, and, on lands where DFB was used, of precluding the need for treatment the following year. Postspray defoliation estimates were made at peak defoliation time in virtually all of the Option I blocks and approximately 50 percent of the Option II blocks. A postseason egg mass count will be made in DFB-treated blocks.

The extensive delayed hatch and subsequent blowing of neonate larvae which occurred during the spring of 1990, severely compromised the integrity of many of the treated blocks. With many of the blocks, blow-in occurred a week or two after spraying and at such intensity that the blow-in population equalled or exceeded the initial pretreatment larval population. As a result, treatment success with Bt was evident in only about 60 percent of the blocks and with DFB, in about 70 percent. A more detailed report on this evaluation will be prepared and be available upon request.

Additional Documentation

The following documents are an integral part of the 1990 gypsy moth suppression project and are available upon request from the Division of Forest Pest Management in Middletown or, where indicated, from the appropriate district office:

- Contract Specifications
- Contractor's Agreement
- County's (Cooperator's) Agreement
- Environmental Assessment
- Work and Safety Plan
- Procedure for Cooperator Participation Manual

- Operating Procedure and Deadlines Manual

- Natural Area Project Reviews
    - Bucktail (Cameron County)
    - Hemlocks (Perry County)
    - Johnson Run (Cameron County)
    - Masland (Perry County)
    - Mount Davis (Somerset County)
    - Pine Ridge (Bedford County)
    - Roaring Run (Westmoreland County)

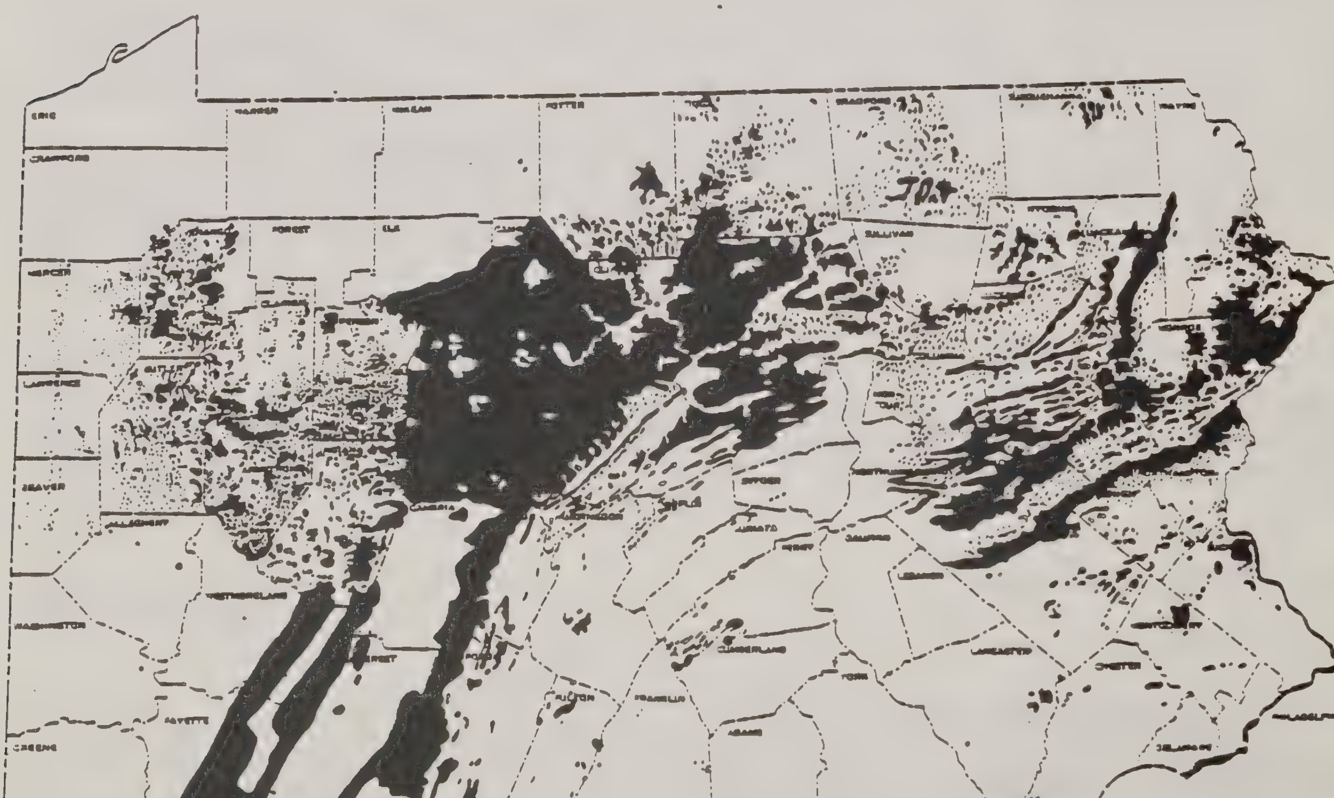
- Spray Block Maps (for review only at district office)

- Proposal Forms (for review only at district office)

- District Project Summaries (for review only at district office)

Defoliation by Gypsy Moth - 1990

The following map and Table 22 provide information on the location and intensity of gypsy moth defoliation which occurred in the Commonwealth during 1990. Moderate defoliation is 31-60 percent while heavy is greater than 61 percent.



Forest District and FPM Areas of Responsibility

During 1990 all 20 forest districts and five FPM areas were involved with a portion of the gypsy moth suppression project. The areas of responsibility in effect in 1990 are shown on the map. DF = district forester, DPL = district gypsy moth program leader, AFPMS = area Forest Pest Management specialist, AAFPMS = assistant area Forest Pest Management specialist.

Kenneth D. Swartz (DF)
Philip Wert (DPL)
Michaux Forest District (1)
10099 Lincoln Way East
Fayetteville, PA 17222
717-352-2211

George R. Winning (DF)
James E. Pflieger (DPL)
Buchanan Forest District (2)
R. D. 2, Box 3
McConnellsburg, PA 17233
717-485-3148

Warren Ely (DF)
Ernest H. Geanette (DPL)
Tuscarora Forest District (3)
R. D. 1, Box 42A
Blain, PA 17006
717-536-3191

David B. Williams (DF)
John T. Wallace (DPL)
Forbes Forest District (4)
P. O. Box 519
Laughlintown, PA 15655
412-238-9533

Ralph E. Heilig (DF)
Paul H. McDonel (DPL)
Rothrock Forest District (5)
Box 403, 418 Penn Street
Huntingdon, PA 16652
814-643-2340

E. Gary Scott (DF)
Thomas E. Grenfell (DPL)
Gallitzin Forest District (6)
131 Hillcrest Drive
Ebensburg, PA 15931
814-472-8320

Robert F. Laubach (DF)
Robert A. Kurilla (DPL)
Bald Eagle Forest District (7)
Box 147
Laurelton, PA 17835
717-922-3344

David L. Steward (DF)
Walter J. Visneski (DPL)
Kittanning Forest District (8)
South Second Avenue
Clarion, PA 16214
814-226-1901

Paul Augustine (DF)
Edward A. Richards (DPL)
Moshannon Forest District (9)
Box 952
Clearfield, PA 16830
814-765-3741

Robert F. Davey, Jr. (DF)
Richard Kugel (DPL)
Sproul Forest District (10)
HCR 62, Box 90
Renovo, PA 17764
717-923-1450

Anthony D. Santoli (DF)
Gerald Kelly (DPL)
Lackawanna Forest District (11)
Room 401, State Office Building
100 Lackawanna Avenue
Scranton, PA 18503
717-963-4561

Charles W. Kiehl (DF)
William C. Miller (DPL)
Tiadaghton Forest District (12)
423 East Central Avenue
South Williamsport, PA 17701
717-327-3450

Robert Martin (DF)
Richard Lancaster (DPL)
Elk Forest District (13)
R. D. 1, Route 155, Box 327
Emporium, PA 15834
814-486-3353

Donald Wary (DF)
James F. Hall/Charles C. Thompson (DPL)
Cornplanter Forest District (14)
323 North State Street
North Warren, PA 16365
814-723-6951

David O. Schiller (DF)
Cornelius Brown (DPL)
Susquehannock Forest District (15)
P. O. Box 673
Coudersport, PA 16915
814-274-8474

John K. Sherwood, Jr. (DF)
Michael Machmer (DPL)
Tioga Forest District (16)
Box 94, Route 287S
Wellsboro, PA 16901
717-724-2868

Maurice Hobaugh (DF)
Jeffrey Stuffle (DPL)
Valley Forest Forest District (17)
R. D. 2, Route 23
Pottstown, PA 19464
215-469-6217

Donald P. Oaks (DF)
Frank Snyder (DPL)
Weiser Forest District (18)
Box 99
Cressona, PA 17929
717-385-2545

Kenneth F. Rhody, Jr. (DF)
Arthur T. Hoehne (DPL)
Delaware Forest District (19)
474 Clearview Lane
Box 150
Stroudsburg, PA 18360
717-424-3001

Robert M. Coy (DF)
Albert Schutz (DPL)
Wyoming Forest District (20)
P. O. Box 439
Bloomsburg, PA 17815
717-387-4255

* * *

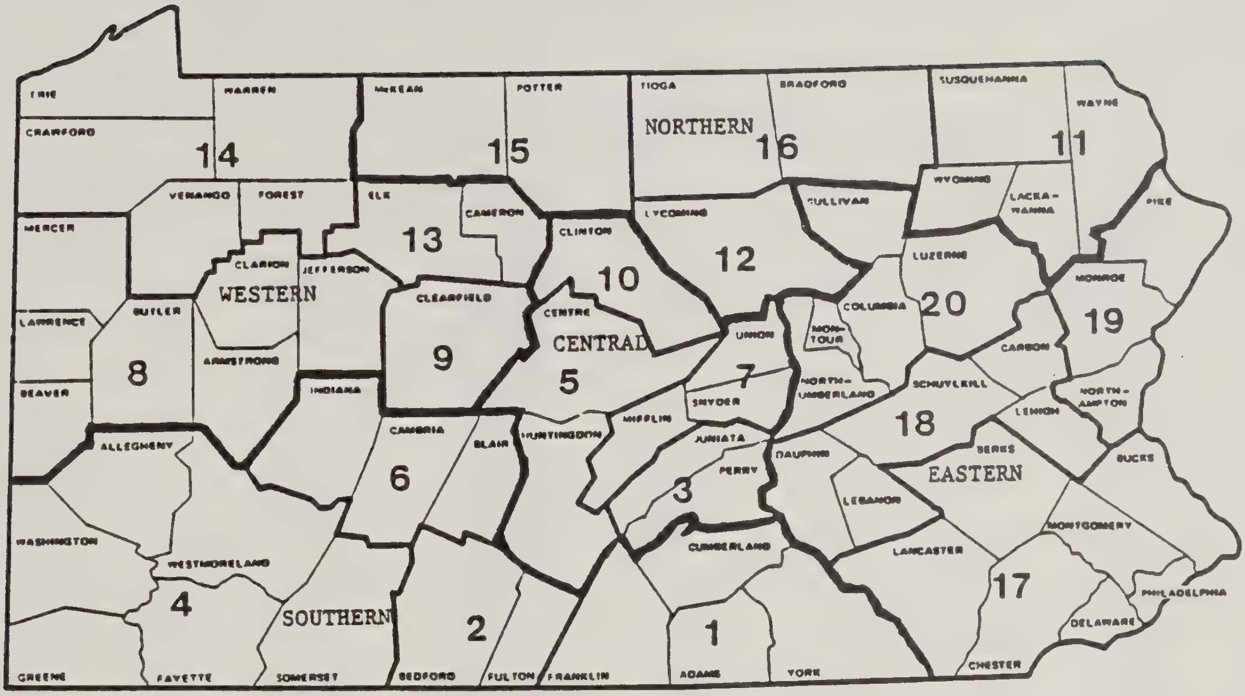
Gary E. Laudermilch (AFPMS)
Northern Area
Box 94, Route 287S
Wellsboro, PA 16901
717-724-2868

Norman C. Kauffman (AFPMS)
Western Area
Box 952
Clearfield, PA 16830
814-765-3741

Thomas C. Bast (AFPMS)
Joseph Gaughan (AAFPMS)
Eastern Area
P. O. Box 439
Bloomsburg, PA 17815
717-387-4255

E. Michael Blumenthal (AFPMS)
Charles R. Hoover (AAFPMS)
Southern Area
HCR 64, Box 130
Harrisonville, PA 17228
814-735-3544

Alan C. Sior (AFPMS)
James D. Unger (AAFPMS)
Central Area
R. D. 1, Box 42A
Blain, PA 17006
717-536-3191


WESTERN
NORTHERN
CENTRAL
SOUTHERN
EASTERN
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ERIE
WARREN
McKEAN
POTTER
TIOGA
BRADFORD
SUSQUEHANNA
WAYNE
CRAWFORD
VENANGO
FOREST
ELK
CAMERON
LYCOMING
SULLIVAN
WYOMING
LACKAWANNA
PIKE
MERCER
CLARION
JEFFERSON
CLINTON
LUZERNE
MONROE
LAWRENCE
BUTLER
CLEARFIELD
CENTRE
UNION
MONTOUR
COLUMBIA
CARBON
ARMSTRONG
NORTHUMBERLAND
SCHUYLKILL
NORTHAMPTON
BEAVER
INDIANA
SNYDER
LEHIGH
CAMBRIA
BLAIR
HUNTINGDON
MIFFLIN
JUNIATA
ALLEGHENY
PERRY
DAUPHIN
BERKS
BUCKS
LEBANON
WASHINGTON
WESTMORELAND
CUMBERLAND
LANCASTER
MONTGOMERY
PHILADELPHIA
DELAWARE
GREENE
FAYETTE
SOMERSET
BEDFORD
FULTON
FRANKLIN
ADAMS
YORK
CHESTER

Table 1. Private residential acreage treated - 1990 - Option I.

County	Forest District	Bt		DFB		County Total	
		Acres	Blocks	Acres	Blocks	Acres	Blocks
Allegheny-IPM	4	2,147	10	1,538	7	3,685	17
Armstrong	8	992	23	-	-	992	23
Bedford	2	1,237	37	-	-	1,237	37
Berks	17	2,119	60	-	-	2,119	60
Blair	6	2,066	6	-	-	2,066	6
Bucks	17	1,592	7	-	-	1,592	7
Butler	8	270	10	-	-	270	10
Cambria	6	1,110	11	-	-	1,110	11
Cameron	13	310	4	-	-	310	4
Carbon	18	8,467	38	-	-	8,467	38
Centre	7	1,787	17	-	-	1,787	17
Chester	17	1,021	2	-	-	1,021	2
Clarion	8	2,670	32	-	-	2,670	32
Clearfield	9	2,169	108	-	-	2,169	108
Clinton	10	542	16	-	-	542	16
Columbia	20	2,039	18	-	-	2,039	18
Crawford	14	435	9	-	-	435	9
Cumberland	1	440	7	-	-	440	7
Elk	13	319	15	-	-	319	15
Forest	14	606	11	-	-	606	11
Franklin	1	688	6	-	-	688	6
Fulton	2	399	1	-	-	399	1
Indiana	6	1,758	44	-	-	1,758	44
Jefferson	8	1,430	34	-	-	1,430	34
Juniata	3	102	1	-	-	102	1
Lackawanna	11	2,084	13	-	-	2,084	13
Lancaster	17	2,260	17	-	-	2,260	17
Lebanon	18	164	3	-	-	164	3
Luzerne	20	6,581	37	-	-	6,581	37
Lycoming	12	1,102	20	-	-	1,102	20
Mercer	8	154	6	-	-	154	6
Monroe	19	25,963	41	-	-	25,963	41
Montgomery	17	1,184	7	-	-	1,184	7
Montour	20	456	19	-	-	456	19
Northampton	19	2,600	36	-	-	2,600	36
Northumberland	20	724	16	-	-	724	16
Perry	3	23	1	-	-	23	1
Pike	19	13,042	57	-	-	13,042	57
Schuylkill	18	4,959	43	-	-	4,959	43
Snyder	7	114	4	-	-	114	4
Somerset	4	2,644	139	-	-	2,644	139
Union	7	155	4	-	-	155	4
Venango	14	3,711	8	-	-	3,711	8
Washington	4	106	3	-	-	106	3
Wayne	11	3,463	10	-	-	3,463	10
Wyoming	11	359	8	-	-	359	8
York	1	605	2	-	-	605	2
Totals		109,168	1,021	1,538	7	110,706	1,028

Table 2. State Forest acreage treated - 1990 - Option I.

Forest District	County	Bt Acres	Bt Blocks	DFB Acres	DFB Blocks	District Total Acres	District Total Blocks
1 (Michaux)	Adams	-	-	476	1	1,400	5
	Cumberland	58	1	283	1		
	Franklin	-	-	583	2		
2 (Buchanan)	Bedford	-	-	1,927	6	2,745	8
	Franklin	-	-	225	1		
	Fulton	-	-	593	1		
3 (Tuscarora)	Cumberland	-	-	437	4	8,850	24
	Franklin	-	-	579	3		
	Perry	-	-	7,834	17		
4 (Forbes)	Fayette	-	-	7,144	13	20,811	23
	Somerset	-	-	9,772	6		
	Westmoreland	-	-	3,895	4		
5 (Rothrock)	Huntingdon	-	-	4,125	6	4,125	6
7 (Bald Eagle)	Centre	-	-	3,351	8	7,775	28
	Clinton	-	-	1,724	7		
	Union	-	-	2,700	13		
8 (Kittanning)	Jefferson	-	-	115	5	402	6
	Venango	287	1	-	-		
9 (Moshannon)	Cameron	-	-	461	2	36,081	73
	Centre	-	-	7,336	8		
	Clearfield	-	-	28,164	61		
	Clinton	-	-	20	1		
	Elk	-	-	100	1		
10 (Sproul)	Clinton	-	-	10,825	7	10,825	7
11 (Lackawanna)	Lackawanna	492	2	-	-	492	2
12 (Tiadaghton)	Lycoming	-	-	2,500	9	2,500	9
13 (Elk)	Cameron	-	-	3,799	13	5,867	22
	Elk	-	-	1,433	7		
	Potter	-	-	635	2		
15 (Susquehannock)	Clinton	-	-	434	2	3,304	10
	Potter	-	-	2,870	8		
16 (Tioga)	Tioga	-	-	4,700	4	4,700	4
18 (Weiser)	Berks	-	-	380	2	1,200	9
	Schuylkill	-	-	820	7		
19 (Delaware)	Monroe	139	3	-	-	2,800	17
	Pike	2,661	14	-	-		
20 (Wyoming)	Columbia	-	-	60	1	60	1
Totals		3,637	21	110,300	233	113,937	254

Table 3. State Park acreage treated - 1990 - Option I.

Park	County	Forest District	Bt		DFB		Park Total	
			Acres	Blocks	Acres	Blocks	Acres	Blocks
Archbald Pothole	Lackawanna	11	26	1	-	-	26	1
Beltzville	Carbon	18	156	1	-	-	156	1
Black Moshannon	Centre	5	350	3	-	-	350	3
Blue Knob	Bedford	2	-	-	1,000	1	1,000	1
Clear Creek	Jefferson	8	320	1	-	-	320	1
Colonel Denning	Cumberland	1	125	1	-	-	125	1
Colton Point	Tioga	16	-	-	75	1	75	1
Frances Slocum	Luzerne	20	200	3	-	-	200	3
Hickory Run	Carbon	18	750	3	-	-	750	3
Hyner View	Clinton	10	-	-	40	1	40	1
Jacobsburg	Northampton	19	405	2	-	-	405	2
Jennings EEC	Butler	8	212	1	-	-	212	1
Kettle Creek	Clinton	10	41	2	-	-	41	2
Keystone	Westmoreland	4	260	1	-	-	260	1
Kooser	Somerset	4	120	1	-	-	120	1
Laurel Hill	Somerset	4	577	2	440	3	1,017	5
Laurel Ridge	Fayette	4	-	-	20	1	152	6
	Somerset		-	-	132	5		
Leonard Harrison	Tioga	16	-	-	100	1	100	1
Laurel Mountain	Westmoreland	4	-	-	154	1	160	2
	Somerset		-	-	6	1		
Laurel Summit	Somerset	4	-	-	25	1	35	2
	Westmoreland		-	-	10	1		
Linn Run	Westmoreland	4	97	3	-	-	97	3
Little Pine	Lycoming	12	303	3	-	-	303	3
Locust Lake	Schuylkill	18	-	-	400	1	400	1
Nockamixon	Bucks	17	200	3	-	-	200	3
Ohiopyle	Fayette	4	255	1	1,425	5	1,680	6
Oil Creek	Venango	14	285	2	-	-	285	2
Ole Bull	Potter	15	94	1	-	-	94	1
Parker Dam	Clearfield	9	250	2	-	-	250	2
Pine Grove Furnace	Cumberland	1	110	2	85	4	195	6
Poe Valley	Centre	5	61	1	-	-	61	1
Promised Land	Pike	19	794	3	-	-	794	3
Pymatuning	Crawford	14	14	1	-	-	14	1
Ricketts Glen	Luzerne	20	535	2	-	-	535	2
Sinnemahoning	Cameron	13	100	6	-	-	106	7
	Potter		6	1	-	-		
Sizerville	Cameron	13	42	2	-	-	150	4
	Potter		108	2	-	-		
Trough Creek	Huntingdon	5	58	2	-	-	58	2
Tuscarora	Schuylkill	18	-	-	100	1	100	1
Yellow Creek	Indiana	6	285	3	-	-	285	3
Totals			7,139	62	4,012	28	11,151	90

Table 4. Federal acreage treated - 1990 - Option I.

Property	Agency*	County	Forest District	Bt		DFB		Property Total	
				Acres	Blocks	Acres	Blocks	Acres	Blocks
Conemaugh	ACOE (P)	Indiana	6	150	3	-	-	150	3
Cowanesque Dam	ACOE (B)	Tioga	16	102	1	-	-	102	1
Crooked Creek	ACOE (P)	Armstrong	8	324	6	-	-	324	6
Loyalhanna	ACOE (P)	Westmoreland	4	42	3	-	-	42	3
Mahoning Creek	ACOE (P)	Armstrong	8	62	1	-	-	62	1
Minersville	BOP	Schuylkill	18	-	-	127	1	127	1
Raystown	ACOE (B)	Huntingdon	5	80	1	-	-	80	1
Youghiogheny	ACOE (P)	Fayette	4	67	4	-	-	164	6
		Somerset		97	2	-	-		
Totals				924	21	127	1	1,051	22

*ACOE (B) = U. S. Army Corps of Engineers (Baltimore)
ACOE (P) = U. S. Army Corps of Engineers (Pittsburgh)
BOP = Federal Bureau of Prisons

Table 5. Other acreage treated - 1990 - Option I.

Property	Agency*	County	Forest District	Bt		DFB		Property Total	
				Acres	Blocks	Acres	Blocks	Acres	Blocks
Bushy Run	PHMC	Westmoreland	4	105	1	-	-	105	1
County Park	WC	Washington	4	-	-	40	1	40	1
Polk Farm	PDA	Venango	14	-	-	301	3	301	3
Somerset Historic Center	PHMC	Somerset	4	28	1	-	-	28	1
Totals				133	2	341	4	474	6

*PDA = Pennsylvania Department of Agriculture
PHMC = Pennsylvania Historical and Museum Commission
WC = Washington County Government

Table 6. Acreage* treated - 1990 - Option II.

County	Cooperator	Forest District	Bt Acres	Bt Blocks	DFB Acres	DFB Blocks	Cooperator Total Acres	Cooperator Total Blocks
Allegheny	County	4	1,048	25	1,697	18	2,745	43
Berks	County	17	4,279	81	-	-	4,279	81
Blair	County	6	6,208	34	-	-	6,208	34
Bucks	County	17	10,375	81	-	-	10,375	81
Butler	County	8	878	35	-	-	878	35
Cambria	County	6	2,993	64	-	-	2,993	64
Carbon	County	18	23,938	107	-	-	23,938	107
	Bethlehem Water Authority	18	505	1	-	-	505	1
Centre	County	5	5,425	87	-	-	5,425	87
Chester	Charlestown Township	17	350	3	-	-	350	3
	South Coventry Township	17	1,080	2	-	-	1,080	2
	Uwchlan Township	17	121	2	-	-	121	2
	West Vincent Township	17	21	1	-	-	21	1
	West Whiteland Township	17	35	2	-	-	35	2
Crawford	County	14	678	3	-	-	678	3
Lackawanna	County	11	6,430	42	-	-	6,430	42
Lancaster	Brecknock Township	17	166	5	-	-	166	5
	Colerain Township	17	113	3	-	-	113	3
	Conestoga Township	17	51	2	-	-	51	2
	East Drumore Township	17	238	6	-	-	238	6
	Eden Township	17	326	4	-	-	326	4
	Martic Township	17	909	13	-	-	909	13
	Paradise Township	17	242	1	-	-	242	1
	Providence Township	17	595	13	-	-	595	13
Lehigh	County	18	3,685	37	-	-	3,685	37
Luzerne	County	20	17,673	130	-	-	17,673	130
Lycoming	County	12	2,429	108	-	-	2,429	108
Mercer	County	8	475	14	-	-	475	14
Monroe	Bethlehem Water Authority	19	176	1	-	-	176	1
	Delaware Water Gap Borough	19	314	1	-	-	314	1
Montgomery	Abington Township	17	87	1	-	-	87	1
	Cheltenham Township	17	77	1	-	-	77	1
	Horsham Township	17	28	2	-	-	28	2
	Lower Frederick Township	17	400	5	-	-	400	5
	New Hanover Township	17	283	7	-	-	283	7
	Salford Township	17	113	3	-	-	113	3
	Springfield Township	17	60	1	-	-	60	1
	Upper Dublin Township	17	122	1	-	-	122	1
	Upper Frederick Township	17	291	3	-	-	291	3
	Upper Moreland Township	17	259	2	-	-	259	2
Northampton	Lehigh Township	19	1,585	15	-	-	1,585	15
	Moore Township	19	2,430	19	-	-	2,430	19
	Upper Mount Bethel Township	19	1,000	10	-	-	1,000	10
Northumberland	County	20	2,391	63	-	-	2,391	63
Pike	County	19	19,511	16	-	-	19,511	16
Schuylkill	County	18	17,815	174	-	-	17,815	174
Somerset	Addison Borough	4	115	1	-	-	115	1
	Boswell Borough	4	276	1	-	-	276	1
	Confluence Borough	4	90	1	-	-	90	1
	Indian Lake Borough	4	1,102	1	-	-	1,102	1
	Windber Borough	4	31	1	-	-	31	1
Venango	County	14	2,020	1	-	-	2,020	1
Wayne	County	11	10,835	63	-	-	10,835	63
York	County	1	1,478	18	-	-	1,478	18
Totals			154,155	1,318	1,697	18	155,852	1,336

*All acreage was in the "Private Residential" ownership category, with the exception of four Bt and all DFB acres in Allegheny County and all Bethlehem Water Authority (Carbon and Monroe Counties) Bt acres which were in the "Other" category.

Table 7. Summary by county and ownership of acreage treated - 1990 - Options I and II.

County	Ownership					
	Private	State Forest	State Park	Federal	Other	Total
Adams	-	476	-	-	-	476
Allegheny	4,729	-	-	-	1,701	6,430
Armstrong	992	-	-	386	-	1,378
Bedford	1,237	1,927	1,000	-	-	4,164
Berks	6,398	380	-	-	-	6,778
Blair	8,274	-	-	-	-	8,274
Bucks	11,967	-	200	-	-	12,167
Butler	1,148	-	212	-	-	1,360
Cambria	4,103	-	-	-	-	4,103
Cameron	310	4,260	142	-	-	4,712
Carbon	32,405	-	906	-	505	33,816
Centre	7,212	10,687	411	-	-	18,310
Chester	2,628	-	-	-	-	2,628
Clarion	2,670	-	-	-	-	2,670
Clearfield	2,169	28,164	250	-	-	30,583
Clinton	542	13,003	81	-	-	13,626
Columbia	2,039	60	-	-	-	2,099
Crawford	1,113	-	14	-	-	1,127
Cumberland	440	778	320	-	-	1,538
Elk	319	1,533	-	-	-	1,852
Fayette	-	7,144	1,700	67	-	8,911
Forest	606	-	-	-	-	606
Franklin	688	1,387	-	-	-	2,075
Fulton	399	593	-	-	-	992
Huntingdon	-	4,125	58	80	-	4,263
Indiana	1,758	-	285	150	-	2,193
Jefferson	1,430	115	320	-	-	1,865
Juniata	102	-	-	-	-	102
Lackawanna	8,514	492	26	-	-	9,032
Lancaster	4,900	-	-	-	-	4,900
Lebanon	164	-	-	-	-	164
Lehigh	3,685	-	-	-	-	3,685
Luzerne	24,254	-	735	-	-	24,989
Lycoming	3,531	2,500	303	-	-	6,334
Mercer	629	-	-	-	-	629
Monroe	26,277	139	-	-	176	26,592
Montgomery	2,904	-	-	-	-	2,904
Montour	456	-	-	-	-	456
Northampton	7,615	-	405	-	-	8,020
Northumberland	3,115	-	-	-	-	3,115
Perry	23	7,834	-	-	-	7,857
Pike	32,553	2,661	794	-	-	36,008
Potter	-	3,505	208	-	-	3,713
Schuylkill	22,774	820	500	127	-	24,221
Snyder	114	-	-	-	-	114
Somerset	4,258	9,772	1,300	97	28	15,455
Tioga	-	4,700	175	102	-	4,977
Union	155	2,700	-	-	-	2,855
Venango	5,731	287	285	-	301	6,604
Washington	106	-	-	-	40	146
Wayne	14,298	-	-	-	-	14,298
Westmoreland	-	3,895	521	42	105	4,563
Wyoming	359	-	-	-	-	359
York	2,083	-	-	-	-	2,083
Totals	264,176	113,937	11,151	1,051	2,856	393,171

Table 8. Summary by ownership and insecticide of acreage treated - 1990 - Option I, Option II, and Options I and II.

Ownership (Option I)	Bt		DFB		Total	
	Acres	Blocks	Acres	Blocks	Acres	Blocks
Private	109,168	1,021	1,538	7	110,706	1,028
State Forest	3,637	21	110,300	233	113,937	254
State Parks	7,139	62	4,012	28	11,151	90
Federal	924	21	127	1	1,051	22
Other	133	2	341	4	474	6
Totals	121,001	1,127	116,318	273	237,319	1,400
(Option II)						
Private	153,470	1,315	-	-	153,470	1,315
State Forest	-	-	-	-	-	-
State Parks	-	-	-	-	-	-
Federal	-	-	-	-	-	-
Other	685	3	1,697	18	2,382	21
Totals	154,155	1,318	1,697	18	155,852	1,336
(Options I and II)						
Private	262,638	2,336	1,538	7	264,176	2,343
State Forest	3,637	21	110,300	233	113,937	254
State Parks	7,139	62	4,012	28	11,151	90
Federal	924	21	127	1	1,051	22
Other	818	5	2,038	22	2,856	27
Totals	275,156	2,445	118,015	291	393,171	2,736

Table 9. Summary of project costs - 1990 - Options I and II.

DER

Expenses

Option I Application/Insecticide Contracts	$1,846,092
Option II Cost Sharing	1,870,224
Overall Operating Costs	1,800,235
Total Expenses	$5,516,551

Credits

Federal Cost Sharing	($3,263,446)
Option I County Cost Sharing	(428,036)
Option I Federal and Other Cooperators' Assessment	(20,362)
Total Credits	($3,711,844)
Net Cost	$1,804,707

Cooperator

Expenses

Option II Application/Insecticide Contracts	$1,936,796
Option I Cost Sharing	428,036
Overall Operating Costs	1,314,565
Total Expenses	$3,679,397

Credits

Option II DER Cost Sharing - Total Credit	($1,870,224)
Net Cost	$1,809,173

Federal

Expenses

State Cost Sharing - Net Cost	$3,263,446

Overall

DER	- $1,804,707	(26.2%)
Cooperator	- 1,809,173	(26.3%)
Federal	- 3,263,446	(47.5%)
Total	- $6,877,326	(100.0%)

Table 10. Application and insecticide contract costs - 1990 - Option I.

	Contract Number						
	90-1	90-2	90-3	90-4	90-5	90-6	Average or Total
Bid Price:							
Bt	$8.43	$10.25	$11.23	$8.63	$8.70	$7.36	$8.31
DFB	6.11	6.50	9.19	6.31	6.38	-	7.03
Acres Treated:							
Bt	15,076	8,025	3,313	15,576	33,407	45,604	121,001
DFB	42,364	10,679	31,615	29,773	1,887	-	116,318
Extra Material*:							
Bt	828	3	12	35	317	1,318	2,513
DFB	34	0	0	2	0	-	36
Actual Cost/Acre:							
Bt	$8.89	$10.25	$11.27	$8.65	$8.78	$7.57	$8.49
DFB	6.11	6.50	9.19	6.31	6.38	-	7.04
Contract Costs:							
Bt	$134,071	$ 82,287	$ 37,340	$134,723	$293,399	$345,346	$1,027,166
DFB	259,052	69,414	290,542	187,880	12,039	-	818,927
Totals	$393,123	$151,701	$327,882	$322,603	$305,438	$345,346	$1,846,093

*Expressed as acre equivalents.

Table 11. Daily spraying progress by contract - 1990 - Option I.

Date	Acres Treated by Contract							Project Cumulation	
	90-1	90-2	90-3	90-4	90-5	90-6	All	Acres	Percent
5/6	-	-	2,377	-	-	-	2,377	2,377	1.0
5/7	3,660	-	3,130	-	3,302	-	10,092	12,469	5.3
5/8	4,558	828	2,772	-	2,799	1,034	11,991	24,460	10.3
5/9	7,096	-	696	2,795	2,467	1,307	14,361	38,821	16.4
5/10	NO SPRAYING - RAIN								
5/11	NO SPRAYING - RAIN								
5/12	3,952	1,694	4,418	2,368	2,731	2,029	17,192	56,013	23.6
5/13	NO SPRAYING - RAIN								
5/14	3,395	5,525	6,490	2,239	2,955	1,718	22,322	78,335	33.0
5/15	4,788	-	2,547	2,421	-	1,026	10,782	89,117	37.6
5/16	NO SPRAYING - RAIN								
5/17	NO SPRAYING - RAIN								
5/18	-	-	95	-	-	1,054	1,149	90,266	38.0
5/19	4,632	773	1,656	2,027	2,698	2,610	14,396	104,662	44.1
5/20	-	1,350	1,140	-	-	-	2,490	107,152	45.2
5/21	3,270	-	3,642	-	-	-	6,912	114,064	48.1
5/22	5,745	2,291	1,793	2,241	3,922	4,368	20,360	134,424	56.6
5/23	8,408	4,133	2,194	2,710	5,969	6,601	30,015	164,439	69.3
5/24	7,936	2,110	1,978	5,332	4,438	8,104	29,898	194,337	81.9
5/25	-	-	-	2,212	4,013	10,927	17,152	211,489	89.1
5/26	NO SPRAYING - RAIN								
5/27	-	-	-	764	-	-	764	212,253	89.4
5/28	-	-	-	-	-	4,826	4,826	217,079	91.5
5/29	NO SPRAYING - RAIN								
5/30	-	-	-	1,102	-	-	1,102	218,181	91.9
5/31	-	-	-	16,405	-	-	16,405	234,586	98.8
6/1	-	-	-	1,754	-	-	1,754	236,340	99.6
6/2	-	-	-	979	-	-	979	237,319	100.0
Totals	57,440	18,704	34,928	45,349	35,294	45,604	237,319		

Table 12. Summary of Option II contracts, costs, and insecticides - 1990.

County	Cooperator	Contractor	Price/ Acre	Insecticide Type	Insecticide Rate/ Acre	Acres	Cooperator Cost	DER Share
Allegheny	County	AgRotors	$12.92	Dipel 8AF	21 BIU	1,048	$ 13,540.16	$ 12,576
		AgRotors	10.58	Dimilin 25W	2 oz	1,697	17,954.26	20,364
Berks	County	Altair	13.75	Dipel 8AF	16 BIU	2,230	30,662.50	26,760
		Altair	13.75	Foray 48B	16 BIU	2,049	28,173.75	24,588
Blair	County	Aero Tech	11.75	Foray 48B	24 BIU	6,208	72,944.00	74,496
Bucks	County	AgRotors	19.60	Dipel 8AF	16 BIU	10,375	203,350.00	124,500
Butler	County	Bob Ruhe	14.90	Dipel 8AF	16 BIU	878	13,082.20	10,536
Cambria	County	Altair	12.50	Dipel 8AF	20 BIU	2,993	37,412.50	35,916
Carbon	County	Bob Ruhe	9.89	Foray 48B	16 BIU	23,938	236,746.82	287,256
	Bethlehem Water Authority	Aero Tech	8.48	Dipel 8AF	16 BIU	505	4,282.40	6,060
Centre	County	Appalachian	15.80	Foray 48B	20 BIU	5,425	85,715.00	65,100
Chester	Charlestown Township	AgRotors	18.10	Dipel 8AF	16 BIU	350	6,335.00	4,200
	South Coventry Township	AgRotors	18.10	Dipel 8AF	16 BIU	1,080	19,548.00	12,960
	Uwchlan Township	AgRotors	18.10	Dipel 8AF	16 BIU	121	2,190.10	1,452
	West Vincent Township	AgRotors	18.10	Dipel 8AF	16 BIU	21	380.10	252
	West Whiteland Township	AgRotors	18.10	Dipel 8AF	16 BIU	35	633.50	420
Crawford	County	Aero Tech	16.00	Dipel 8AF	16 BIU	678	10,848.00	8,136
Lackawanna	County	Aero Tech	9.60	Foray 48B	20 BIU	6,430	61,728.00	77,160
Lancaster	Brecknock Township	K & K Aircraft	19.10	Foray 48B	16 BIU	166	3,170.60	1,992
	Colerain Township	AgRotors	22.60	Dipel 8AF	16 BIU	113	2,553.80	1,356
	Conestoga Township	AgRotors	22.00	Dipel 8AF	16 BIU	51	1,122.00	612
	East Drumore Township	AgRotors	24.60	Dipel 8AF	16 BIU	238	5,854.80	2,856
	Eden Township	AgRotors	22.60	Dipel 8AF	16 BIU	326	7,367.60	3,912
	Martic Township	AgRotors	14.10	Dipel 8AF	16 BIU	909	12,816.90	10,908
	Paradise Township	AgRotors	22.60	Dipel 8AF	16 BIU	242	5,469.20	2,904
	Providence Township	AgRotors	22.60	Dipel 8AF	16 BIU	595	13,447.00	7,140
Lehigh	County	Cordoba	13.79	Dipel 8AF	16 BIU	3,685	50,816.15	44,220
Luzerne	County	K & K Aircraft	9.86	Dipel 8AF	16 BIU	17,673	174,255.78	212,076
Lycoming	County	Helicopter Applicators	14.00	Dipel 8AF	16 BIU	2,429	34,006.00	29,148
Mercer	County	Altair	14.00	Foray 48B	16 BIU	475	6,650.00	5,700
Monroe	Delaware Water Gap Borough	AgRotors	18.50	Dipel 8AF	16 BIU	314	5,809.00	3,768
	Bethlehem Water Authority	Aero Tech	8.48	Dipel 8AF	16 BIU	176	1,492.48	2,112

Table 12. Summary of Option II contracts, costs, and insecticides - 1990 (continued).

County	Cooperator	Contractor	Price/ Acre	Insecticide		Acres	Cooperator Cost	DER Share
				Type	Rate/ Acre			
Montgomery	Abington Township	Evergreen	25.97	Dipel 8AF	16 BIU	87	2,259.39	1,044
	Cheltenham Township	Evergreen	25.97	Dipel 8AF	16 BIU	77	1,999.69	924
	Horsham Township	Evergreen	25.97	Dipel 8AF	16 BIU	28	727.16	336
	Lower Frederick Township	Evergreen	25.97	Dipel 8AF	16 BIU	400	10,388.00	4,800
	New Hanover Township	Evergreen	25.97	Dipel 8AF	16 BIU	283	7,349.51	3,396
	Salford Township	Evergreen	25.97	Dipel 8AF	16 BIU	113	2,934.61	1,356
	Springfield Township	Evergreen	25.97	Dipel 8AF	16 BIU	60	1,558.20	720
	Upper Dublin Township	Evergreen	25.97	Dipel 8AF	16 BIU	122	3,168.34	1,464
	Upper Frederick Township	Evergreen	25.97	Dipel 8AF	16 BIU	291	7,557.27	3,492
	Upper Moreland Township	Evergreen	25.97	Dipel 8AF	16 BIU	259	6,726.23	3,108
Northampton	Lehigh Township	Cordoba	13.79	Dipel 8AF	16 BIU	1,585	21,857.15	19,020
	Moore Township	Cordoba	13.79	Dipel 8AF	16 BIU	2,430	33,509.70	29,160
	Upper Mount Bethel Township	K & K Aircraft	17.61	Dipel 8AF	16 BIU	1,000	17,610.00	12,000
Northumberland	County	AgRotors	16.53	Dipel 8AF	16 BIU	2,391	39,523.23	28,692
Pike	County	Aero Tech	8.35	Dipel 8AF	16 BIU	1,380	11,523.00	16,560
		Aero Tech	8.99	Dipel 8AF	16 BIU	4,938	44,392.62	59,256
		Aero Tech	9.48	Dipel 8AF	16 BIU	2,316	21,955.68	27,792
		AgRotors	10.42	Dipel 8AF	16 BIU	5,426	56,538.92	65,112
		AgRotors	13.80	Dipel 8AF	16 BIU	5,451	75,223.80	65,412
Schuylkill	County	Cordoba	11.87	Dipel 8AF	16 BIU	17,815	211,464.05	213,780
Somerset	Addison Borough	AgRotors	20.94	Dipel 8AF	16 BIU	115	2,408.10	1,380
	Boswell Borough	AgRotors	19.14	Dipel 8AF	16 BIU	276	5,282.64	3,312
	Confluence Borough	AgRotors	23.74	Dipel 8AF	16 BIU	90	2,136.60	1,080
	Indian Lake Borough	AgRotors	13.84	Dipel 8AF	16 BIU	1,102	15,251.68	13,224
	Windber Borough	AgRotors	28.64	Dipel 8AF	16 BIU	31	887.84	372
Venango	County	Altair	10.25	Foray 48B	16 BIU	520	5,330.00	6,240
		Altair	10.25	Condor OF	16 BIU	1,500	15,375.00	18,000
Wayne	County	Aero Tech	11.75	Dipel 8AF	20 BIU	10,835	127,311.25	130,020
York	County	Aero Tech	9.60	Foray 48B	20 BIU	1,478	14,188.80	17,736
Totals						155,852	$1,936,796.06	$1,870,224

Table 13. Insecticide used - 1990 - Option I and Option II.

Insecticide	Formulation	Rate/Acre	Volume/ Acre (Oz)	Diluted or Undiluted*	Acres		
					Option I	Option II	Total
Bt	Condor OF	24 BIU	128	D	6,280	1,500	7,780
	Dipel 8AF	16 BIU	128	D	98,184	91,090	189,274
		16 BIU	96	D	2,596	0	2,596
		20 BIU	128	D	0	13,828	13,828
		21 BIU	96	D	0	1,048	1,048
	Foray 48B	16 BIU	128	D	2,807	27,148	29,955
		20 BIU	128	D	0	13,333	13,333
		20 BIU	53	U	6,622	0	6,622
		24 BIU	128	D	3,109	6,208	9,317
		30 BIU	80	U	1,403	0	1,403
DFB	Dimilin 25W	.004 oz AI	128	D	100	0	100
		.04 oz AI	128	D	100	0	100
		.4 oz AI	128	D	105,439	0	105,439
		.4 oz AI	96	D	10,679	0	10,679
		.5 oz AI	128	D	0	1,697	1,697
					237,319	155,852	393,171

*Water used as carrier with all diluted applications; no stickers were added to any application.

Table 14. Spray aircraft utilized - 1990 - Option I.

Aircraft		Contractor	Pilot	Contract
Model	Registration Number			
Ag Truck 188	N2200F	Altair	F. Staunch	5
	N70482	Altair	G. Glenn	5
Air Tractor 400	N23720	Altair	R. Everett	1
	N501JK	Altair	R. Rawlings	1
Air Tractor 502	N1002L	Altair	D. Willis	1, 4*
	N1005S	Altair	J. Beadle	5, 4*
			P. Rouleau	4*
	N1006Y	Altair	J. Morgan	5, 4*
			P. DeMaeyer	4*
	N502JP	Altair	T. Lefebvre	1, 4*
Bell Soloy	N121CD	Helicopter Applicators	M. Haworth	3
	N7936S	Helicopter Applicators	J. Klocker	3
Bull Thrush	N2239S	Altair	W. Ketch	4
	N2239X	Altair	P. Anderson	4
DC-3	N56KS	K & K Aircraft	K. Stoltzfus	6
Grumman Ag-Cat	N7155J	Altair	L. Myelle	4
	N7155P	Altair	R. Wallace	4
Sikorsky S-55	N37799	Helicopter Applicators	D. Webb	3
Turbo Thrush	N7155S	Altair	W. Hamilton	2, 4*
	N7155W	Altair	P. DeMaeyer	2, 4*
Twin Beech	N1002C	K & K Aircraft	B. Senger	6
	N1400E	K & K Aircraft	J. Ethell	6
Twin Beech Turbine	N38L	K & K Aircraft	R. Kiser	6

*Contract restrictions prevent the designation of the same aircraft for two or more contracts by the same contractor. These aircraft were permitted to move to the second contract only after their obligation to the initial contract had been met.

Table 15. Spray aircraft calibration - 1990 - Option I.

Aircraft		Nozzles				Boom Length (Feet)	Air Speed (mph)	Lane (Feet)	Flow Rate (gpm)		
Model	Registration Number	Tip	Number	Angle°	Material				Desired	Set	± (%)
Ag Truck 188	N2200F	D4-45	46	45	SS*	32.3	120	75	18.2	18.0	-1.1
	N70482	D4-45	47	45	SS	30.1	115	75	17.4	17.0	-2.3
Air Tractor 400	N23720	D8-45	40	90	SS	32.3	150	100	30.3	30.3	0.0
	N501JK	D8-45	39	90	SS	32.3	150	100	30.3	30.0	-0.1
Air Tractor 502	N1002L	D8-45	32	45	SS	41.0	150	100	30.3	30.0	-0.1
	N1005S	D6-45	49	45	SS	37.7	140	100	28.2	29.0	+2.8
	N1006Y	D6-45	49	45	SS	37.7	140	100	28.2	29.0	+2.8
	N502JP	D8-45	35	90	SS	41.3	150	100	30.3	31.0	+2.3
Bell Soloy	N121CD	8003	45	45	SS	33.7	70	100	14.1	13.7	-2.8
	N7936S	8003	48	45	SS	31.3	65	100	13.1	12.8	-2.3
Bull Thrush	N2239S	D6-45	47	90	SS	40.0	135	100	27.3	27.0	-1.1
	N2239X	D6-45	47	90	SS	40.0	135	100	27.3	27.0	-1.1
DC-3	N56KS	8020	50	45	SS	74.0	160	300	97.0	97.0	0.0
Grumman Ag-Cat	N7155J	D4-45	52	45	SS	30.3	100	100	20.2	20.5	+1.5
	N7155P	D4-45	52	45	SS	30.3	100	100	20.2	20.0	-1.0
Sikorsky S-55	N37799	8004	53	45	SS	36.0	70	125	17.7	17.2	-2.8
Turbo Thrush	N7155S	AU5000	6	-	-	30.7	135	100	11.4	11.4	0.0
	N7155W	AU5000	6	-	-	30.7	135	100	11.4	11.4	0.0
Twin Beech	N1002C	8020	16	45	SS	37.2	160	100	32.3	32.0	-1.0
	N1400E	8020	16	45	SS	37.2	160	100	32.3	32.3	-1.0
Twin Beech Turbine	N38L	8020	16	45	SS	38.3	160	100	32.0	32.0	0.0

*SS = stainless steel

Table 16. Individual spray aircraft production data - 1990 - Option I.

Volume/ Acre (Ounce)	Aircraft		Pilot	Production							
	Model	Reg. No.		Flight Time (Hours)	Blocks*	Loads	Gallons Sprayed	Acres Sprayed	Average Block Size**	Gallons/ Load	Acres/ Hour
53.3	Turbo Thrush	N7155S	W. Hamilton	17.3	57	12	1,379	3,313	58	115	192
	Turbo Thrush	N7155W	P. DeMaeyer	17.3	57	12	1,379	3,313	58	115	192
80.0	Turbo Thrush	N7155S	W. Hamilton	1.4	2	3	438	702	351	146	501
	Turbo Thrush	N7155W	P. DeMaeyer	1.4	2	3	438	702	351	146	501
96.0	Turbo Thrush	N7155S	W. Hamilton	24.0	64	25	4,978	6,637	104	199	277
	Turbo Thrush	N7155W	P. DeMaeyer	24.0	64	25	4,978	6,637	104	199	277
128.0	Ag Truck 188	N2200F	F. Staunch	46.1	113	50	6,163	6,163	55	124	134
	Ag Truck 188	N70482	G. Glenn	50.2	118	54	6,920	6,920	59	128	139
	Air Tractor 400	N23720	R. Everett	36.4	89	45	13,429	13,429	151	298	369
	Air Tractor 400	N501JK	R. Rawlings	35.9	111	44	12,987	12,987	117	295	362
	Air Tractor 502	N1002L	D. Willis	50.5	156	46	15,747	15,747	101	342	312
	Air Tractor 502	N1005S	J. Beadle	56.6	171	43	15,062	15,062	88	350	266
	Air Tractor 502	N1006Y	J. Morgan	59.6	182	45	16,010	16,010	88	356	269
	Air Tractor 502	N502JP	T. Lefebvre	50.9	141	51	17,257	17,257	122	338	339
	Bell Soloy	N121CD	M. Haworth	31.1	43	105	10,691	10,691	249	102	344
	Bell Soloy	N7936S	J. Klocker	38.4	28	132	12,021	12,021	429	91	313
	Bull Thrush	N2239S	W. Ketch	35.1	75	35	10,758	10,758	143	307	307
	Bull Thrush	N2239X	P. Anderson	41.0	109	40	12,167	12,167	112	304	297
	DC-3	N56KS	K. Stoltzfus	26.0	29	26	24,490	24,490	844	942	942
	Grumman Ag-Cat	N7155J	L. Myelle	42.5	63	42	6,198	6,198	98	146	148
	Grumman Ag-Cat	N7155P	R. Wallace	27.6	18	19	3,736	3,736	208	197	135
	Sikorsky S-55	N37799	D. Webb	28.9	46	81	12,228	12,228	266	151	423
	Twin Beech	N1002C	B. Senger	58.7	90	46	14,851	14,851	165	323	253
	Twin Beech	N1400E	J. Ethell	25.3	38	19	5,979	5,979	157	315	236
	Twin Beech Turbine	N38L	R. Kiser	5.3	9	5	1,602	1,602	178	320	302

*When a block was sprayed in tandem, it was counted as a block treated for each of the aircraft. This resulted in a greater number of blocks being recorded than were actually in the project (1,400).

**When a block was sprayed in tandem, the acreage within the block was assigned proportionately to the appropriate aircraft. This resulted in a smaller effective average block size for aircraft used extensively in that manner.

Table 17. Production data by aircraft model - 1990 - Option I.

Aircraft Model	Percent of Project	Production							
		Flight Time (Hours)	Blocks*	Loads	Gallons Sprayed	Acres Sprayed	Average Block Size**	Gallons/ Load	Acres/ Hour
Ag Truck 188	5.5	96.3	231	104	13,084	13,084	57	126	136
Air Tractor 400	11.0	72.3	200	89	26,416	26,416	132	297	365
Air Tractor 502	26.7	217.6	650	185	64,076	64,076	99	346	294
Bell Soloy	9.5	69.5	71	237	22,712	22,712	320	96	327
Bull Thrush	9.6	76.1	184	75	22,927	22,927	125	307	301
Douglas DC-3	10.2	26.0	29	26	24,490	24,490	844	942	942
Grumman Ag-Cat	4.1	70.1	81	61	9,934	9,934	123	163	142
Sikorsky S-55	5.1	28.9	46	81	12,228	12,228	266	151	423
Turbo Thrush	8.9	85.4	248	80	13,590	21,304	87	170	249
Twin Beech	8.7	84.0	128	65	20,830	20,830	163	320	248
Twin Beech Turbine	.7	5.3	9	5	1,602	1,602	178	320	302
Totals		831.5	1,877	1,008	231,889	239,603	218	230	288

*When a block was sprayed in tandem, it was counted as a block treated for each of the aircraft. This resulted in a greater number of blocks being recorded than were actually in the project (1,400).

**When a block was sprayed in tandem, the acreage within the block was assigned proportionately to the appropriate aircraft. This resulted in a smaller effective average block size for aircraft used extensively in that manner.

Table 18. Observation aircraft used - 1990 - Option I.

Contract	District	Aircraft Model	Aircraft Registration Number	Pilot(s)	Observer(s)	Cost/Hour	Hours Flown	Cost
1	8	Cessna 172	N17676Q	D. Sheets	M. Bodamer	$ 85.00	12.65	$ 1,075.25
	9	Cessna 172	N86510	A. Sallade	A. Reinke	56.00	12.20	683.20
	13	None used.						
	14	Cessna 172	N19673	D. Kudlak/C. Sharrer	C. Thompson	65.00	9.60	624.00
		Cessna 172	N65003	T. Brugh	C. Thompson	65.00	4.50	292.50
2	11	None used.						
	12	None used.						
	15	Cessna 172	N7335H	A. Sallade	C. Brown	65.00	10.50	682.50
	16	Cessna 172	N80952	R. Johnston	W. Beacom	55.00	1.80	99.00
		Cessna 182	N8303S	R. Johnston	W. Beacom	65.00	6.36	413.40
3	3	Cessna 177	N30979	S. Snyder	G. Bell	140.00	6.80	952.00
	5	Cessna 172	N62350	L. Garbrick	R. Pawlowski	62.00	11.00	682.00
		Cessna 172	N736CN	L. Garbrick	R. Pawlowski	62.00	7.00	434.00
	7	Cessna 172	N62350	L. Garbrick	L. Johnson	62.00	9.35	579.70
	10	Cessna 172	N736CN	L. Garbrick	J. Prowant/J. Fiedor	65.00	30.00	1,950.00
4	1	None used.						
	2	None used.						
	4	None used.						
	6	Cessna 172	N65623	P. Rhoades	G. Scott	49.00	11.50	563.50
5	17	None used.						
	18	Cessna 172	N54910	S. Inhoffer/J. Conahan	L. Newswanger	59.99	46.70	2,801.53
	20	Cessna 182D	N8757X	F. Pavelko	D. Hartwigsen	75.00	10.70	802.50
6	19	None used.						
Average/Total						$66.27	190.66	$12,635.08

Table 19. Spray aircraft utilized - 1990 - Option II.

Contractor	Aircraft		Pilot
	Model	Registration Number	
Aero Tech	Air Tractor 400	N23649	Jim Uselton
	Air Tractor 400	N2369N	Ted Stallings
	Air Tractor 400	N3160Q	Danny Howland
	Air Tractor 400	N611CP	Carl Payne
AgRotors	Bell 204	N847MC	Victor Gray
	Bell 206	N206BX	David Bortscheller
	Bell 206	N206BY	Carl Mosegard
	Bell 206	N49718	Mike Smith
	Bell 206	N9907K	Dan Riley
	Bell 212	N8530B	Timothy Voss
	Hughes 500D	N1097J	Maurice Messersmith
	Hughes 500D	N5027P	Gary Dobler
Altair	Air Tractor 401	N23720	Ray Everitt
	Air Tractor 401	N501JK	Bob Rawlings
	Air Tractor 502	N1002L	Dwight Willis
	Air Tractor 502	N502JP	Tom Lefebvre
	Bull Thrush	N2239S	Wayne Ketch
	Bull Thrush	N2239X	Paul Anderson
	Bull Thrush	N7143J	Jim Seitz
	Grumman Ag-Cat	N7155J	Len Myelle
	Grumman Ag-Cat	N7155P	Bob Wallace
Appalachian	Bell 204	N9846F	Stephen Karschner
Bob Ruhe	Ag Husky	N21933	Don Recker
	Turbo Thrush	N4021G	Kent Miese
	Turbo Thrush	N8460V	Charles Moon
Cordoba	Ag Truck	N1992J	Jim Lackey
	Ag Truck	N2695J	John Cutts
	Ag Truck	N731ET	Carl Myers
Evergreen	Bell 206	N59612	Ronald Wolf
Helicopter Applicators	Bell Soloy	N122CD	Rick Farwell
K & K Aircraft	DC-3	N177H	Fred Coons
	Grumman Ag-Cat	N602U	Paul Duffy/Mike Hensel
	Grumman Ag-Cat	N913X	Mike Hensel
	Turbo Thrush	N4001T	Caleb Glick
	Twin Beech	N1002C	Bruce Senger
	Twin Beech	N1400E	Jeff Ethell
	Twin Beech	N38L	Richard Kiser

Table 20. Individual spray aircraft production data - 1990 - Option II.

Volume/ Acre (Ounce)	Aircraft		Pilot	Production							
	Model	Reg. No.		Flight Time (Hours)	Blocks*	Loads	Gallons Sprayed	Acres Sprayed	Average Block Size**	Gallons/ Load	Acres/ Hour
53.3	Air Tractor 400	N23649	J. Uselton	16.2	106	18	2,308	5,716	54	128	353
	Air Tractor 400	N3160Q	D. Howland	13.3	102	17	2,255	5,872	58	133	442
	Air Tractor 400	N611CP	C. Pane	13.3	106	14	2,304	5,706	54	165	479
128.0	Ag Huskey	N21933	D. Recker	23.2	57	24	2,802	2,802	49	117	121
	Ag Truck	N1992J	J. Lackey	23.0	45	49	4,984	4,984	111	102	217
	Ag Truck	N2695J	J. Cutts	81.6	144	74	13,207	13,207	92	178	162
	Ag Truck	N731ET	C. Myers	41.9	66	61	8,083	8,083	122	133	193
	Air Tractor 400	N23649	J. Uselton	17.0	49	22	6,576	6,576	134	299	387
	Air Tractor 400	N2369N	T. Stallings	2.1	10	3	531	531	53	177	283
	Air Tractor 400	N23720	R. Everitt	3.6	9	4	1,268	1,268	141	317	352
	Air Tractor 400	N3160Q	D. Howland	8.5	23	13	4,170	4,170	181	321	491
	Air Tractor 400	N501JK	R. Rawlings	3.4	6	4	1,227	1,227	205	307	361
	Air Tractor 400	N611CP	C. Pane	15.4	48	23	6,415	6,415	134	279	417
	Air Tractor 502	N1002L	D. Willis	7.7	42	5	1,582	1,582	38	316	205
	Air Tractor 502	N502JP	T. Lefebvre	12.8	45	7	2,145	2,145	48	306	168
	Bell 204	N847MC	V. Gray	5.0	5	7	1,614	1,614	323	231	323
	Bell 204	N9846F	S. Karschner	16.7	95	30	5,898	5,898	62	197	151
	Bell 206	N206BX	D. Bortscheller	48.0	131	198	18,626	18,626	142	94	388
	Bell 206	N206BY	C. Mosegard	10.1	12	38	3,417	3,417	285	90	338
	Bell 206	N59612	R. Wolf	8.0	25	19	1,726	1,726	69	91	216
	Bell 206	N9907K	D. Riley	13.4	69	83	5,742	5,742	83	83	429
	Bell Soloy	N122CD	R. Farwell	15.6	101	28	2,429	2,429	24	87	156
	Bull Thrush	N2239S	W. Ketch	1.7	7	1	268	268	38	268	158
	Bull Thrush	N2239X	P. Anderson	1.0	1	1	250	250	250	250	250
	Bull Thrush	N7143J	J. Seitz	7.4	34	10	2,241	2,241	66	224	303
	DC-3	N177H	F. Coons	5.7	18	4	3,792	3,792	211	948	665
	Grumman Ag-Cat	N602U	M. Hensel	7.5	20	12	1,998	1,998	100	167	266
	Grumman Ag-Cat	N602U	P. Duffy	10.8	17	16	2,674	2,674	157	167	248
	Grumman Ag-Cat	N7155J	L. Myelle	1.5	2	2	70	70	35	35	47
	Grumman Ag-Cat	N7155P	R. Wallace	2.4	1	2	310	310	310	155	129
	Grumman Ag-Cat	N913X	M. Hensel	16.9	28	21	4,447	4,447	159	212	263
	Hughes 500	N1097J	M. Messersmith	6.8	25	11	1,097	1,097	44	100	161
	Hughes 500	N5027P	G. Dobler	8.3	34	14	1,294	1,294	38	92	156
	Twin Beech	N1002C	B. Senger	3.4	7	2	573	573	82	287	169
	Twin Beech	N1400E	J. Ethell	6.7	14	5	1,577	1,577	113	315	235
	Twin Beech	N38L	R. Kiser	2.2	4	2	670	670	168	335	305
	Thrush	N52R	G. Glick	14.9	41	14	3,169	3,169	77	226	213
	Turbo Thrush	N4021G	K. Miese	24.6	60	31	9,970	9,970	166	322	405
	Turbo Thrush	N8460V	C. Moon	23.7	39	36	12,101	12,101	310	336	511

*When a block was sprayed in tandem, it was counted as a block treated for each of the aircraft. This resulted in a greater number of blocks being recorded than were actually in the project (1,336).

**When a block was sprayed in tandem, the acreage within the block was assigned proportionately to the appropriate aircraft. This resulted in a smaller effective average block size for aircraft used extensively in that manner.

Table 21. Production data by aircraft model - 1990 - Option II.

Aircraft Model	Percent of Project	Production							
		Flight Time (Hours)	Blocks*	Loads	Gallons Sprayed	Acres Sprayed	Average Block Size**	Gallons/ Load	Acres/ Hour
Ag Huskey	2	23.2	57	24	2,802	2,802	49	117	121
Ag Truck	17	146.5	255	184	26,274	26,274	103	143	179
Air Tractor 400	24	92.8	459	118	27,058	37,481	82	229	404
Air Tractor 502	2	20.5	87	12	3,727	3,727	43	311	182
Bell 204	5	21.7	100	37	7,512	7,512	75	203	346
Bell 206	19	79.5	237	338	29,511	29,511	125	87	371
Bell Soloy	2	15.6	101	28	2,429	2,429	24	87	156
Bull Thrush	2	10.1	42	12	2,759	2,759	66	230	273
DC-3	2	5.7	18	4	3,792	3,792	211	948	665
Grumman Ag-Cat	6	39.1	68	53	9,499	9,499	140	179	243
Hughes 500	2	15.1	59	25	2,391	2,391	41	96	158
Twin Beech	2	14.5	25	9	2,820	2,820	113	313	194
Thrush	2	14.9	41	14	3,169	3,169	77	226	213
Turbo Thrush	14	48.3	99	67	22,071	22,071	223	329	457

*When a block was sprayed in tandem, it was counted as a block treated for each of the aircraft. This resulted in a greater number of blocks being recorded than were actually in the project (1,336).

**When a block was sprayed in tandem, the acreage within the block was assigned proportionately to the appropriate aircraft. This resulted in a smaller effective average block size for aircraft used extensively in that manner.

Table 22. Pennsylvania gypsy moth defoliation - 1990.

County	Acres		Total
	Moderate	Heavy	
Allegheny	300	400	700
Armstrong	90,800	44,200	135,000
Beaver	1,100	500	1,600
Bedford	93,500	8,100	101,600
Berks	7,400	42,200	49,600
Blair	85,600	25,400	111,000
Bradford	12,800	40,700	53,500
Bucks	2,000	15,700	17,700
Butler	28,400	23,100	51,500
Cambria	8,700	32,300	41,000
Cameron	95,400	131,300	226,700
Carbon	5,700	136,600	142,300
Centre	28,700	180,900	209,600
Chester	900	1,100	2,000
Clarion	26,300	13,800	40,100
Clearfield	100,000	200,000	300,000
Clinton	7,800	241,900	249,700
Columbia	3,300	65,200	68,500
Crawford	400	200	600
Cumberland	800	100	900
Elk	176,200	79,400	255,500
Fayette	33,700	65,900	99,600
Franklin	1,000	200	1,200
Fulton	4,900	0	4,900
Huntingdon	12,800	200	13,000
Indiana	0	111,400	111,400
Jefferson	61,400	54,800	116,200
Juniata	1,500	0	1,500
Lackawanna	8,500	86,500	95,000
Lancaster	100	2,900	3,000
Lawrence	700	0	700
Lehigh	4,000	18,700	22,700
Luzerne	23,600	179,900	203,500
Lycoming	23,100	424,900	448,000
McKean	400	2,800	3,200
Mercer	9,700	4,100	13,800
Mifflin	2,400	600	3,000
Monroe	41,200	107,300	148,500
Montgomery	500	5,500	6,000
Montour	700	1,800	2,500
Northampton	19,100	16,300	35,400
Northumberland	14,800	21,400	36,200
Perry	3,800	3,200	7,000
Pike	65,000	112,200	177,200
Potter	17,800	17,100	34,900
Schuylkill	4,700	218,700	223,400
Snyder	200	0	200
Somerset	43,900	55,100	99,000
Sullivan	6,300	7,300	13,600
Susquehanna	11,700	4,500	16,200
Tioga	31,800	55,700	87,500
Union	3,200	50,300	53,500
Venango	47,700	38,000	85,700
Washington	0	100	100
Wayne	1,900	14,400	16,300
Westmoreland	37,100	37,100	74,200
Wyoming	35,200	5,300	40,500
57 Counties	1,350,500	3,007,300	4,357,700

National Steering Committees for Aerial Application of Pesticides
Gypsy Moth and Other Eastern Defoliators

Summary of AIPM Activities - 1990

The Appalachian Integrated Pest Management (AIPM) Gypsy Moth Program supported numerous methods improvement and pilot/special projects in FY 90. These activities were conducted cooperatively with USDA Forest Service - FIDR and FPM; Agricultural Research Service, Animal and Plant Health Inspection Service; WV/VA Departments of Agriculture; and universities.

Several of the priorities identified by the members of the Gypsy Moth and Other Eastern Defoliators Committee at the annual meeting in Columbus, OH in 1989 were addressed:

Laboratory Tests

1 - Literature data base of Dimilin non-target effects (not human health) computerized, accessible by cooperators, and maintained by AIPM in Morgantown.
ONGOING

2 - Funding provided to Dave Miller (U of CT) to evaluate meteorological parameters associated with deciduous forests as inputs into FSCBG.
ONGOING

Field Tests

1 - Field test conducted to compare efficacy resulting from application of Bt (Foray 48B) using different types of atomizers. No significant differences among dosages (20 and 30 BIU/A) and atomizers (flat fan 8004, Micronair AU-5000, Twin Jet 8004) for foliage protection or population reduction. Control populations showed significant natural mortality.
COMPLETE

2 - Efficacy of Gypchek when aerially applied at standard and two reduced dosages. The standard (5 x 10" PIB/A applied twice) dose was not significantly different from the 2.5 x 10" PIB/A dose but both significantly different from the 1.25 x 10" dose.
COMPLETE - see attached write-up

Demononstration Projects

1 - Multiple applications of Gypchek against high density (up to 22,000 EM/A) isolated populations of gypsy moth. Efficacy results excellent as only one new egg mass.
COMPLETE

Pilot Projects

1 - Compare efficacy of Dipel 6 AF and Foray 48B applied undiluted at 30 BIU/A. Uncorrected population reduction was approximately 70%.
COMPLETE

Equipment, Models and Technology Development

1 - Utility of FSCBG to predict canopy penetration by comparing deposition predictions to observed for eastern deciduous canopies.
ONGOING

AIPM Activities (as of 11/90) - 1991

Laboratory Tests

1 - Update and maintain Dimilin non-target database.

2 - Continue funding Miller (U of CT) to evaluate meteorological parameters associated with eastern deciduous forests as inputs into FSCBG.

Field Tests

1 - Work cooperatively with NEFAAT and *Bt* companies to broaden application timing window for *Bt* to eastern deciduous forests for reduction of gypsy moth populations.

2 - Work cooperatively with FIDR - RWU - 4502 to evaluate efficacy of Gypchek across years to suppress low (30-80 EM/A) density gypsy moth populations.

3 - Develop for operational use a "ready to use" formulation of Gypchek.

4 - Evaluate aerial application of flake and bead formulations of racemic disparlure in terms of efficacy and pheromone persistence.

Equipment, Models and Technology Development

1 - Continue funding Yendol (PSU) to evaluate observed vs predicted (FSCBG) canopy deposition for eastern deciduous canopies.

Pilot Projects

1 - Continue funding studies to determine potential non-target effects of *Bt* on aquatic macroinvertebrates, canopy arthropods and food of endangered Virginia Big-eared Bat; Dimilin on terrestrial/aquatic salamanders, canopy arthropods, aquatic macroinvertebrates, and soil microflora and arthropods in closed watersheds; and gypsy moth defoliation on canopy arthropods.

STATUS OF GYPSY MOTH NPV, GYPCHEK, IN USA

John Podgwaite[1], Richard Reardon[2] and Harry Hubbard[1]
[1]Forest Insect and Disease Research, USDA Forest Service, Hamden, CT
[2]Northeastern Area, State & Private Forestry, USDA Forest Service, Morgantown, WV

In 1960, the USDA Forest Service began to explore the feasibility of developing *Bacillus thuringiensis* (*Bt*) and the gypsy moth nucleopolyhedrosis virus as alternatives to chemical insecticides for suppressing gypsy moth populations. By 1970, over 25 strains of *Bt* had been evaluated against the gypsy moth; and in 1978, the gypsy moth nucleopolyhedrosis virus product Gypchek was approved (Environmental Protection Agency) for registration by the U.S. Forest Service.

Since its registration and prior to 1987, various Gypchek formulations were aerially-applied at various dosages and rates, and in the evening and morning using various types of aircraft and nozzles. Efficacy results were often inconsistent (Podgwaite), due in part, to inadequate sunscreens in the formulations, and marginal application dosages. In 1987, an improved Gypchek formulation containing molasses and Orzan LS (a lignosulfonate) was field tested in Maryland with improved efficacy results (Webb et al., J. Econ. Entomol. 82:1695-1701, 1989). The formulation (Orzan LS-6% W/V, molasses - 12.5% V/V, and Rhoplex 2% V/V) has been maintained and when applied at 2 gal/A and 5×10^{11} PIB/A for each of two applications (3-days apart) is considered the standard. The necessity for 2 applications (3 days apart) at 2 gal/A/appl, the limited supply of product, and the increased demand has resulted in the initiation of a series of field studies designed to increase efficacy and reduce cost. In 1988, the standard formulation of Gypchek was applied using the same application parameters as in 1987 except against higher density gypsy moth populations (800-3,500 egg masses/A) in more mountainous terrain. These results were encouraging (ave net pop. reduction 94% and foliage protection 45% (Podgwaite in press). In 1989, the standard formulation was applied using 2 applications (3-days apart) at 5×10^{11} PIB/A per application and also using 1 application at 1×10^{12} PIB/A. The results were not encouraging for the use of one instead of two applications (8% and 40% net population reduction and 18% and 44% foliage protection, respectively). In 1990, the standard formulation was applied using 2 applications for each of three dosages: 5×10^{11} PIB/A, 2.5×10^{11}, and 1.25×10^{11}. The highest dosage provided uncorrected population reduction of 84% and foliage protection of 50% as compared to the other dosages (85% and 74%; and 46% and 47%, respectively).

Gypchek is presently being phased into commercial development using in vivo and in vitro systems. Also, additional strains (e.g. Abington) have been identified and the search is continuing for more virulent strains. Further, new and improved formulations of Gypchek are being researched and will be field-tested as they become available.

The current recommendation is to use the standard formulation of Gypchek applied twice 3-days apart, 2 gal/A and 5×10^{11} PIB/A per appl., against moderate to high density (300-5,000 EM/A) populations.

LIST OF TANK MIXES AND ATOMIZERS EVALUATED IN WIND TUNNEL

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SECTION 2

THIRD ANNUAL REPORT

National Steering Committee - Management Of Seed and Cone Insects

A Report of the Portland, Oregon Meeting - June 12-14, 1990

September 7, 1990

USDA Forest Service
Washington Office/Forest Pest Management
2121 C 2nd Street
Davis, CA 95616
(916)758-4600
FTS 460-1715

CONTENTS

I. INTRODUCTION

The second meeting of this committee during FY 1990 was held in Portland, Oregon, June 12-14, 1990 and included a field trip to five seed orchards.

A. Members Present

Larry Barber	R-8/FPM (Asheville, NC)
Scott Cameron	TX Forest Service (Lufkin, TX)
Gary DeBarr	SE/FIDR (Athens, GA)
Jed Dewey	R-1/FPM (Missoula, MT)
Wayne Dixon	FL Division of Forestry (Gainesville, FL)
Mike Haverty	PSW/FIDR (Berkeley, CA)
Tom Hofacker	WO/FPM (Washington, DC)
Charles Masters	Weyerhaueser Co. (Centralia, WA)
Chris Niwa	PNW/FIDR (Corvallis, OR)
Max Ollieu	WO/FPM (Washington, DC)
Roger Sandquist	R-6/FPM (Portland, OR)
Tim Schowalter	Oregon State University
John Taylor	R-8/FPM (Atlanta, GA)
Jack Barry (Chairperson)	WO/FPM (Davis, CA)

Three other members, Peter deGroot and Kees van Frankenhuyzen (FPMI); and Dave Overhulser, Oregon Department of Forestry were not able to attend.

B. Purpose of Meeting

The purpose of the meeting was to review status of field projects, review technical project proposals, and to visit production orchards in the Willamette Valley.

II. STATUS OF PROJECTS

Summarized below is status of completed or on-going projects that relate to committee recommendations.

A. Field Experiments and Related Studies

1. Chris Niwa is conducting monitoring studies of Douglas-fir chalcid in Douglas-fir seed orchards.

2. Mike Haverty is conducting impact studies of seed and cone insects in western white pine and sugar pine seed orchards.

3. Tim Schowalter is conducting studies on impact of the conifer seed bug on western white pine flower buds, flowers, and cones.

4. Gary DeBarr is conducting field studies to establish lower threshold values of pesticides to control seed bugs.

5. Mike Haverty, Chuck Masters, and others have initiated single-tree studies to evaluate pyrethroid insecticides (Asana, Talstar and Capture) to control Douglas-fir cone gall midge. Also included in these studies is a test of dimethoate for control of the Douglas-fir cone gall midge.

B. Demonstrations

1. FSCBG aerial spray model is being evaluated in conjunction with tests conducted at the Schroeder and Horning seed orchards in Oregon. Field tests have been completed. A comparison test planned for the southeast was cancelled.

2. Larry Barber demonstrated use of fire to control white pine cone beetle pest of eastern white pine in Ohio, North Carolina, and Pennsylvania.

C. Cooperative Field Projects

1. Jose Negron and Larry Barber conducted tests using *Bacillus thuringiensis* to control *Dioryctria* spp. in slash pine in Florida and Louisiana.

2. Roger Sandquist conducted an aerial application project at the Schroeder and Horning orchards in Oregon to control a Douglas-fir pest complex.

3. Gary DeBarr, in cooperation with Chris Niwa, Jack Nord, Jose Negron, and Larry Barber, evaluated the feasibility of using a pheromone to disrupt mating of *Dioryctria disculsa* in loblolly pine.

4. Chuck Richmond is studying pesticide residues in western larch foliage from implants and Jose Negron is conducting similar implant studies in southern pines.

D. Administrative

Provisional list of pesticides currently registered for control of seed and cone insects is enclosed (Appendix A).

E. Other Comments and Observations

1. Committee members noted that there will be an increase in need for seed to support national programs - the Conservation Reserve Program, America Beautiful, the Stewardship Program.

2. Chuck Masters reported that the western seed orchard managers are very supportive of research identified by this committee and offer their orchards as test sites. Managers also are supportive of Forest Service efforts in seeking relaxation of pheromone registration requirements.

3. Gary DeBarr suggested we invite an FIDR manager to join the committee. It was noted that FIDR has been receiving committee reports and Max Ollieu has extended invitations to WO/FIDR to attend those meetings.

4. Jed Dewey reported that several seed orchards are coming on-line in Region 1.

5. Mike Haverty mentioned that support for seed and cone research at PSW is declining. The PSW seed and cone research program has need for laboratory support for residue, non-target, and environment analysis. Chris Niwa also noted that future of pheromone research at PNW is uncertain.

6. Roger Sandquist and Tim Hofacker commented on the excellent cooperation on seed and cone insect projects.

7. John Taylor offered to conduct NIPRS searches on pesticides registered for seed and cone insects. The process is complicated due to wide variation in registration approaches taken by registrants. John also agreed to provide copies of MSDS for these insecticides.

8. Bill Ciesla noted that Region 6 will be doing an environmental impact statement for Region 6 seed orchards. There are many seed orchards coming on-line in the Region.

9. Max Ollieu commented that since Jim Space became director of FPM, the FPM budget has increased by $20 million. There are, therefore, funds to support committee recommendations.

10. Max Ollieu also noted that WO/FPM wants the national steering committees to establish priorities for all projects they recommend.

[illegible] of pesticides [illegible] [illegible] (Appendix A).

Other Comments and Contributions

1. Committee members noted that there will be [illegible] forward [illegible] national programs - the Conservation Reserve Program, Rocky Mountain [illegible], the Stewardship Program.

2. Chuck Wellner reported that the western seed orchard managers are very supportive of the research identified by this [illegible] and offer their orchards as test sites. [illegible] also [illegible] of Forest Service efforts in [illegible] of [illegible] demonstration [illegible].

3. Gary [illegible] to invite [illegible] IOP [illegible] the committee. [illegible] noted that [illegible] has been [illegible] committee. [illegible] has extended invitations to [illegible] to attend these meetings.

4. [illegible] reported that [illegible] are coming on-line in Region 1.

5. Mike Haverty [illegible] support [illegible] PSW is [illegible]. The PSW [illegible] laboratory support for [illegible] environmental analyses. [illegible] also noted that [illegible] of [illegible] PSW is uncertain.

6. Roger Sandquist and [illegible] commented on the excellent cooperation on seed and cone insect [illegible].

7. Jean Taylor offered to consult [illegible] registered for seed and cone insects. The [illegible] due to [illegible] registration approaches [illegible] requirements. Jean also agreed to provide [illegible] for these [illegible].

8. Bill Ciesla noted that Region 6 will be doing an environmental [illegible] for Region 6 seed orchards. There are [illegible] on-line in the Region.

[illegible] commented that since Jim [illegible] became director of FPM, [illegible] increased by [illegible]. There are [illegible] to support committee recommendations.

[illegible] also noted that the WO/FPM [illegible] national steering [illegible] priorities for all [illegible] they

11. John Taylor will pursue the need to obtain pesticide rate data for seed bugs and use of a modeling approach to calculate application rates of hydraulic and other ground sprays.

12. Committee members noted the need for ground application technology and for seed orchards. This should include studies on tree injection equipment, drift, and safety.

13. The committee expressed concern about dilution of skills for managing seed and cone insects. Regions, Area, and Stations have the responsibility of taking the lead in this area with committee members serving as staff advisors to management on this issue.

14. Max Ollieu and John Taylor reported progress in discussions with EPA about pheromone registration. This is being coordinated with ARS. There is a need for a protocol on developing and obtaining pesticide registration data.

15. Jim McDivitt, WO/Policy and Analysis has been assigned responsibility for a Policy Analysis Review of Forest Service Pesticide Policy.

16. Wayne Dixon, Florida Division of Forestry, in cooperation with Carl Fatzinger, Southeastern Forest Experiment Station, reported progress in developing an IPM Decision System for seed and cone insect management in slash pine.

III. REVIEW OF PROJECT PROPOSALS

The primary purpose of the meeting was to review proposals that will be submitted to FPM for funding in FY 1991. FPM has established a Project Task Force to review, prioritize, and recommend project funding. The National Steering Committee - Management of Seed and Cone Insects volunteered to review proposals and offer constructive suggestions before the proposals are submitted to the Task Force.

The committee reviewed eight proposals, offered suggestions and rated them numerically (Appendix B). The rating took into consideration potential of the research to reduce use of pesticides, a national vs local application of findings, and level of cooperation. We believe the exercise will result in improved project proposals and a coordinated seed and cone insect research program.

IV. FIELD TRIP

We toured five tree improvement facilities on June 13-14, 1990. See Appendix C for a complete description of the five facilities.

A. J.E. Schroeder Seed Orchard, Oregon State Department of Forestry, St. Paul, Oregon. Acting Manager - Richard Yaeger.

[illegible] than
for [illegible] [illegible] to [illegible]
[illegible] [illegible] [illegible] and [illegible].

12. Committee people noted the need for [illegible] technology and for [illegible] [illegible]. [illegible] should [illegible] on [illegible] equipment, [illegible], and safety.

13. The committee [illegible] for [illegible] and [illegible] have the [illegible] of [illegible] with [illegible] [illegible] staff [illegible] to [illegible] issue.

14. [illegible] with [illegible] with [illegible]. There [illegible] need [illegible] the [illegible].

15. [illegible] has been [illegible] [illegible] Policy.

16. [illegible] with [illegible] [illegible] [illegible].

III. [illegible] PROJECT PROPOSALS

The primary [illegible] of the [illegible] that will be submitted to [illegible] Project Task Force to review [illegible] [illegible] National Steering Committee [illegible] the proposals [illegible].

The committee [illegible] [illegible] (Appendix D). The rating [illegible] of the [illegible] [illegible] national [illegible] application of findings, and level of [illegible]. We believe the [illegible] will result in improved project proposals and a [illegible] and more [illegible] program.

[illegible]

[illegible] [illegible] [illegible] 13-1[illegible], 19[illegible]. See [illegible] description of the five [illegible].

[illegible] State Department of Forestry. [illegible] [illegible] Fishery [illegible].

Field tests are being conducted to evaluate aerial treatment of trees 30 feet in height.

B. Research Center Seed Orchard, Georgia - Pacific Corporation, Eugene, Oregon. Manager - Matt Higgins.

1. Need a pest monitoring system for deciding control strategies.

2. Currently using prophalytic approach for insect control.

C. Dorena Tree Improvement Center, Umpqua National Forest, Cottage Grove, Oregon. Manager - Joe Linn.

1. Need technology to reduce amounts of pesticides.

2. Need technical assistance to monitor movement of pesticides as a campground and stream are located about 1/4 mile from an orchard.

D. Travis Tyrrell Seed Orchard, Bureau of Land Management, Lorane, Oregon. Manager - Fred Borchert.

Effective pest management has potential of greatly reducing need to manage the current planned net acreage of 420 acres of seed trees.

E. Turner Seed Orchard, Weyerhaeuser Company, Turner, Oregon. Manager - Don Dotter.

Currently using prophylactic approach for insect control.

V. SUMMARY

The National Steering Committee - Management of Seed and Cone Insects met in Portland, Oregon, June 12-14, 1990, to review status of field projects, to review technical project proposals, and to visit seed orchards in the Willamette Valley. The Committee accomplished these purposes and through such meetings, focuses the national seed and cone insect management expertise on research and other needs to support the national tree improvement and reforestation program. We promote cooperation among the Federal, State, and private sectors. Eight proposals were reviewed, critiqued, and ranked by priority. Needs identified during the field trip included: method to monitor off-target movement of pesticides; system to monitor insect pests; reduction in use of pesticides; and pest control strategies tailored to individual orchards. The next meeting is scheduled to be held June 12-14, 1991, at Boone, North Carolina, hosted by John W. Taylor and Larry Barber.

APPENDIX A

(DRAFT)

Notes on Pesticides Registered for Control of Seed and Cone Insects

Pesticides that may be registered for control of seed and cone insects include:

Pesticide	Manufacturer	Remarks
Acephate (Orthene 75S)	Valent USA Corp.	Florida, Georgia, North Carolina, South Carolina, Virginia, and Texas
Azinphos-Methyl (Guthion 2S, 2L, 35WP, 2EC)	Mobay Corp. MicroFlo Co. West	 Guthion 2EC
<u>Bacillus thuringiensis</u>	Novo BioKontrol Abbott Laboratories Sandoz, Ltd.	
Bifenthrin (Capture 2E) (Talstar)	FMC Corp. FMC	24C registration pending
Carbaryl (Sevin)	Rhone-Poulenc	To control western spruce budworm
Carbofuran	FMC Corp.	Deregistration pending
Dimethoate	American Cyanamid Co. IMC Corp.	
Esfenvalerate (Asana XL)	E.I. duPont de Memours & Co., Inc.	
Malathion	Kerr McGee Chemical Co. (Fasco label)	Florida-slash pine flower thrips
Metasystox R	Bayer AG Mobay Corp.	Not used in South
Permethrin (Ambush) (Pounce)	 ICI Agrochemicals FMC	 All Southern States " " "
Propargite (Omite)	Uniroyal Chemical Co.	24C registration in Oregon?

Note: This is a tentative list that has not been verified. Check Federal and State labels before recommending or using these or any other pesticides.

(Continued)

Primary insects that target seed and cones by geographical area include the following:

Southeast
- Southern pines: Coneworms, seedbugs, white pine cone beetle, cone borer, seed worms, pine seed chalcid, pine conelet looper.

Northwest
- Douglas-fir: Douglas-fir cone gall midge; Douglas-fir scale midge; Douglas-fir cone moth; Douglas-fir cone worm; and Douglas-fir seed chalcid.
- Western White Pine: seed moth, coneworm, and cone beetle.
- Ponderosa Pine: seed worm and cone beetle.
- Sugar Pine: seed worms and cone beetle.
- General: seed bugs

Northeast
- Spruce: eastern spruce budworm; spruce cone midge; spruce cone worm; spruce cone maggot; and spruce seed moth.
- Eastern White Pine: white pine cone beetle; white pine cone borer; European pine shoot moth; seed midges.
- Red and Jack Pine: Jack pine budworm; red pine cone beetle; webbing coneworm; eastern pine seedworm; and Nantucket pine tip moth.

Pacific Southwest - Insects ranked within tree species by estimated order of importance.
- Douglas-fir: Douglas-fir gall midge causes serious annual losses in some coastal regions; Douglas-fir cone moth in some inland areas such as eastern part of Klamath and common in cone shipments to Placerville Nursery; Douglas-fir coneworm will become a problem as orchard develop; and Douglas-fir seed chalcid has impacted seed from some northern California forests.
- Ponderosa pine: Cone beetle; seedworms; coneworms;
- Sugar pine: cone beetle; and Dioryctria sp. (one known instance of serious damage in a breeding orchard).
- White and red fir: fir seed maggot is very common in seed collections; Dioryctria spp. common in collections.
- General: western conifer seed bug is a big concern to tree improvement foresters.

Northern Rocky Mountains
- Western White Pine: seedbug, coneworm, and cone beetle.
- Douglas-fir: coneworm, cone moth, western spruce budworm and midges.

Intermountain and Rocky Mountain

North Central

Southwest

APPENDIX B

RANKING OF SEED AND CONE PROJECT PROPOSALS

	Project	Score
1.	Development of an aerial simulator - NEGRON and CAMERON.	2.75
2.	Pilot test of Capture and Foray - NEGRON and BARBER.	2.75
3.	Technology for use of behavioral chemicals to control *Conopthorus* sp. in white pine - BARBER and DEBARR.	2.50
4.	Monitoring *Megastigmus* sp. in Douglas-fir with sticky color panels - NIWA and SANDQUIST.	2.25
5.	Control of over wintering Douglas-fir cone gall midge and seed chalcid - NIWA and SANDQUIST.	2.25
6.	Techniques to measure spray deposits in orchard canopies - BARBER, et al.	2.00
7.	Monitoring with semiochemicals and control strategies for conifer seed bug - SOWER and SANDQUIST.	1.91
8.	Accountancy - residue from Acephate implants - SANDQUIST, et al.	1.27

Ranked by priority with number 1 being the highest priority.

Species: Douglas-fir
Western Hemlock

Year Initiated: 1974

Size (acres)
Gross: 400
Net: 160

Manager:

Address: 3700 Mahony Rd. NE
St. Paul, OR 97137

Phone: (503) 378-3429

Location: About 20 miles north of Salem & 7 miles west of Woodburn, OR.
Legal Description: Sections 7 & 18, T.5 S. R.2 W., W.M. and Sections 12 & 13, T.5 S. R.3 W., W.M.
Elevation: 170'

Orchard Seed will be Used by the Following Organizations, Ranger Districts, Work Units, etc.: Boise Cascade, Fred VanEck, Hampton Tree Farms, International Paper, Longview Fibre, Miami Corp., Oregon State Dept. of Forestry, Port Blakely Tree Farms, Simpson Timber Co., Starker Forests, Stimson Lumber Co., & Willamette Ind.

Seedzones Represented by this Material: 041, 051, 052, 053, 061, 062, 251, 261, 262, 452, & 461.

Acreage to be Reforested with Orchard Seed: Approximately 1.5 million.

Will Surplus Seed be Available for Sale? If so, when? (Include contact person if different from above) Each cooperator will determine if and when surplus seed will be available.

Has this Orchard been Certified by an Appropriate State Seed Certification Agency? If not, will it be? None have been certified to date, although some programs probably will be in the future.

CULTURAL PRACTICES

Vegetation Management and Cover Crops: The practice is to maintain a cover crop in all orchards. A variety of fescue and rye grasses are being used.

Fertilization: Nutrient levels are monitored and prescription mixed fertilizers are applied as needed.

Cone and Pollen Stimulation Techniques: Orchards are managed on an individual family target basis. Up to one half of the trees of each family are stimulated each year (based upon how closely that family's natural production meets its target). Stimulation treatments involve double overlapping girdles and calcium nitrate fertilization (at a rate of 200 pounds of nitrogen/acre.

Supplemental Mass Pollination: SMP is practiced in the younger orchards to enhance juvenile seedset. It is also being evaluated as a means of increasing genetic quality and increasing the number of filled seed per cone. The technique being used is to collect pollen and reapply it using an air powered wand.

Problem Cone and Seed Insects: Insect pests include gall midge, chalcid, Dioryctria, and seed bugs.

Insect Control Methods: As necessary, a "Turbo-Mist" orchard sprayer is used to apply insecticides such a Pydrin, Dimethoate and Metasystox-R.

Orchard Inventory / Monitoring System: An inventory/monitoring system is used to estimate crop size only. A survey is taken after the flowers are pendent, but prior to vegetative budburst. The number of flowers is estimated on randomly selected "survey" trees (about a 12% sample); every tenth survey tree is both estimated and counted, thereby calibrating the estimate. We are moving toward a more detailed method to give better

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

individual family estimates where clean picking may not be desired. At harvest, each tree's cone production is measured and recorded, then cones are bulked into family lots.

Records/Database Management System: Data is managed on an AT-class PC, which is linked to a mainframe (via modem). Software includes "R:BASE for DOS" and "Lotus 1-2-3."

Irrigation System: None, however adjacent landowners supply water on an as needed basis.

Frost Control Methods: Helicopters have been planned for large seed needs (yet have never been used).

Harvesting Methods: A combination of ladders, manlifts and tree shakers have been used. Appropriate methods are a function of tree heights and crop size.

Special Problems: Spacing is a problem. Roguing leaves clumps and gaps; because of the close initial spacing, these clumps quickly become crowded and shaded.

Research Needs / Studies Underway: Improved SMP efficiency is needed and is currently being investigated. Better insect control above 30 feet in height is also needed and being investigated.

PROGRAM/BREEDING ZONE:	Molalla	NWA[a]	Sunday Cr.[b]	Snow Peak	Umpqua
ORCHARD INFORMATION					
Species	DF	DF	DF	DF	DF
Age	15	11	16	11	14
# Clones/Families	57	25[c]	11[c]	62	79
Material Type	FS	FS	FS	FS	FS
Orchard Acreage	14	13	6	16	12
Tree Spacing:					
Initial	4x12	5x15	24x36	5x15	4x12
Current	24x36	30x45	24x36	30x30	24x36
Final	24x36	30x45	24x36	30x30[d]	24x36
Design	geog.	syst.	syst.	geog.	syst.
Seed Production:					
1980	7/20	0/0	0/0	0/0	0/5
1981	0/10	0/0	0/0	0/0	0/18
1982	0/9	0/0	0/0	0/0	2/5
1983	20/100	0/0	0/0	0/0	0/9
1984	7/37	0/0	0/0	0/2	0/7
1985	14/33	0/0	0/0	0/0	8/26
1986	136/530	0/0	0/0	0/42	143/575
1987	13/64	0/0	0/0	1/52	25/112
1988	202/672	0/0	46/210	12/99	241/870
Target #/year	90	10	35	95	35
Roguing Dates:					
First	1981	1984	1982	1984	1982
Next	1984	n/a	1985	?	1988
Replacement Date	1996	never[a]	2000	2005	2000
GENETIC TEST INFORMATION			Old / New		
# of Tests	9	3	3 / 4	20	8
Test Age	21	20	23 & 21 / 9	15,16,17	21,18,17
# of Genotypes	375	150	900 / 84	401	600
Test Type	OP	OP	OP / OP	OP	OP
Last Measured	1983	1983	1988 / 1985	1988,'89	1988

PROGRAM/BREEDING ZONE:	Burnt Woods	Dallas Low	Dallas High	Vernonia[b]	Tillamook	Nehalem[a]
ORCHARD INFORMATION						
Species	DF	DF	DF	DF	WH	DF
Age	14	7	7	18	9	planned
# Clones/Families	57	25[c]	11[c]	102	307	
Material Type	FS	FS	FS	FS	RC	
Orchard Acreage	15	17	10	36	3.2	
Tree Spacing:						
Initial	4x12	5x15	5x15	4x12	12x12	
Current	24x36	24x36	24x36	24x36	12x12	
Final	24x36	24x36	24x36	24x36	12x12	
Design	geog.	random	random	geog.[e]	syst.	
Seed Production:						
1980	0/10	0/0	0/0	4/11	0/0	
1981	0/30	0/0	0/0	0/80	0/0	
1982	0/0	0/0	0/0	15/40	0/0	
1983	0/32	0/9	0/0	33/263	0/0	
1984	0/2	0/0	0/0	74/291	0/0	
1985	11/416	0/0	0/0	348/532	0/0	
1986	33/214	0/0	0/0	406/1427	0/0	
1987	10/35	0/0	0/0	87/334	0/0	
1988	186/771	0/0	0/0	593/2017	0/3	
Target #/year	145	102	60	300	3	120
Roguing Dates:						
First	1981	1988	1988	1982	1990	
Next	?	?	?	1985	?	
Replacement Date	2004	2009	2009	1997	?	

GENETIC TEST INFORMATION	Burnt Woods Old	Burnt Woods New	Dallas Low	Dallas High	Vernonia	Tillamook Old	Tillamook New	Nehalem
# of Tests	8	8	10	10	12	22	2	10
Test Age	21	7	17	10	21 & 23	14 & 12	9	5
# of Genotypes	161	300	225	202	900	270	60	400
Test Type	OP	OP	OP	OP	OP	OP	OP	OP
Last Measured	1987	1989	1987	1987	1988	1985	1985	1989

Additional Comments:

[a] NWA will be merged with Nehalem Orchard (to the extent that genotypes are compatible between the two areas).

[b] The Sunday Creek Orchard was separated from the Vernonia Orchard in 1988. Prior information was reported as part of the Vernonia Orchard.

[c] Additional material will be infused in the future.

[d] Geographic design by elevation of parent trees.

[e] Three adjoining blocks that represent parentage from different land ownerships (separated by cooperator from north to south).

Species: Douglas-fir

Year Initiated: 1973

Size (acres)
Gross: 80
Net: 50

Manager: Matt Higgins

Address: P.O. Box 1618
Eugene, OR 97440

Phone: (503) 689-1221

Location: Cottage Grove, OR.
Legal Description: Section 18, T.21 S. R.2 W., W.M.
and Section 13, T.21 S. R.3 W., W.M.
Elevation: 900'

Orchard Seed will be Used by the Following Organizations, Ranger Districts, Work Units, etc.: Georgia-Pacific timberlands in western Oregon.

Seedzones Represented by this Material: 053, 061, 072, 081, and 461.

Acreage to be Reforested with Orchard Seed: 315,000.

Will Surplus Seed be Available for Sale? If so, when? (include contact person if different from above) Yes, seed is available now. Contact Phil Hahn at the above address and phone number.

Has this Orchard been Certified by an Appropriate State Seed Certification Agency? If not, will it be? No.

CULTURAL PRACTICES

Vegetation Management and Cover Crops: Mowing of natural cover crop. Strip spray herbicides within tree rows.

Fertilization: Hand-applied urea at a rate of 200 pounds nitrogen/acre. Applied only to flowering trees.

Cone and Pollen Stimulation Techniques: Girdling and $CaNO_3$ fertilization on one quarter of each orchard per year.

Supplemental Mass Pollination: Considering but not yet operational.

Problem Cone and Seed Insects: Gall midge, seed chalcid, Dioryctria, and seed bug.

Insect Control Methods: Dimethoate is applied (0.5%) when flowers are three quarters pendant. Acecap implants have been used on a trial basis. Pydrin is also used for seed bug control in June-July.

Orchard Inventory / Monitoring System: Survival and production surveys are done in the Spring.

Records/Database Management System: IBM-AT computer for data processing and map making. Use Lotus 1-2-3 and Paradox software.

Irrigation System: Under-Crown irrigation system with the capacity for irrigating about 4 acres at a time.

Frost Control Methods: Under-crown frost protection linked to temperature monitoring system at adjacent container nursery.

Harvesting Methods: Ladders and tree climbing.

Special Problems: Rocky ground prohibits tree moving.

Research Needs / Studies Underway: Acecap study on selected clones.

Additional Comments: Rex Timber's holdings have reverted to their original status as belonging to Georgia-Pacific Corp.

PROGRAM/BREEDING ZONE:	Coquille-High	Sixes	Sitkum
ORCHARD INFORMATION			
Species	DF	DF	DF
Age	15	15	15
# Clones/Families	60	33	37
Material Type	grafts	grafts	grafts
Orchard Acreage	5	5	5
Tree Spacing:			
Initial	12x16	12x16	12x16
Current	var.	var.	var.
Final	var.	var.	var.
Design	syst.	syst.	syst.
Seed Production:			
1980	0/0	0/0	0/0
1981	0/0	0/0	0/0
1982	0/0	0/0	0/0
1983	0/0	0/0	0/0
1984	0/0	0/0	0/0
1985	0/0	0/0	0/0
1986	0/0	0/0	0/0
1987	11/59	18/66	23/80
1988	5/35	11/48	8/37
Target #/year	15	15	15
Roguing Dates:			
First	1991	1991	1991
Next	1995	1995	1995
Replacement Date	2005	2005	2005
GENETIC TEST INFORMATION			
# of Tests	3	3	3
Test Age	1 & 2	1 & 2	1 & 2
# of Genotypes	91	60	64
Test Type	OP & PMX	OP & PMX	OP & PMX
Last Measured	n/a	n/a	n/a

PROGRAM/BREEDING ZONE:	Toledo-High	Toledo-Low	Springfield	RCCB*
ORCHARD INFORMATION				
Species	DF	DF	DF	DF
Age	15	15	15	1-6
# Clones/Families	55	55	60	730
Material Type	grafts	grafts	grafts	grafts
Orchard Acreage	6	6	13	8
Tree Spacing:				
Initial	12x16	12x16	12x16	12x20
Current	var.	var.	var.	12x20
Final	var.	var.	var.	24X20
Design	syst.	syst.	syst.	syst.
Seed Production:				
1980	0/0	0/0	0/0	0/0
1981	0/0	0/0	0/0	0/0
1982	0/0	0/0	0/0	0/0
1983	0/0	0/0	0/0	0/0
1984	0/0	0/0	0/0	0/0
1985	0/0	0/0	0/0	0/0
1986	0/0	0/0	0/0	0/0
1987	28/100	23.2/105	1/7	0/0
1988	33/146	11.4/72	24/81	0/0
Target #/year	20	20	?	n/a
Roguing Dates:				
First	1992	1992	n/a	
Next	1997	1997	n/a	
Replacement Date	2005	2005	?	
GENETIC TEST INFORMATION				
# of Tests	3	3	none	16
Test Age	2 & 1	2 & 1		15, 12, 2, & 1
# of Genotypes	182	182		692
Test Type	OP & PMX	OP & PMX		OP & PMX
Last Measured	n/a	n/a		1988

* Clone Bank/Breeding Orchard

Species: Western White Pine
Sugar Pine

Year Initiated: 1956

Size (acres)
Gross: 88
Net: 60

Manager: Joe Linn

Address: P.O. Box 7
Cottage Grove, OR 97424

Phone: (503) 942-5526

Location: 6 miles east of Cottage Grove, OR.
Legal Description: Section 23, T.20 S. R.2 W., W.M.
Elevation: 700'

Orchard Seed will be Used by the Following Organizations, Ranger Districts, Work Units, etc.: Throughout Oregon and Washington, primarily by National Forests.

Seedzones Represented by this Material: 081, 082, 090, 451, 452, 462, 463, 472, 473, 482, 491, 492, 493, 501, 511, and 512.

Acreage to be Reforested with Orchard Seed: Suitable lands throughout Washington and Oregon.

Will Surplus Seed be Available for Sale? If so, when? (Include contact person if different from above) No.

Has this Orchard been Certified by an Appropriate State Seed Certification Agency? If not, will it be? Yes.

CULTURAL PRACTICES

Vegetation Management and Cover Crops: Grass cover crop maintained by mowing and hand cutting close to trees.

Fertilization: Ammonium nitrate (34-0-0) at 200 lbs/acre in alternate years.

Cone and Pollen Stimulation Techniques: Nitrate fertilization.

Supplemental Mass Pollination: None practiced at the present.

Problem Cone and Seed Insects: *Leptoglossus occidentalis* ("seedbug"), *Dioryctria abietivorella*, and *Conophthorus ponderosae*.

Insect Control Methods: Sugar pine controlled crosses are remain bagged from the time of pollination through harvesting. ASANA has been used as part of administrative studies.

Orchard Inventory / Monitoring System: Seed production records are kept on an individual-tree basis, and rotate to tree vigor and insect/disease problems. Pre-inventory crop estimation is not practiced.

Records/Database Management System: Data managed primarily on a Data General mini-computer.

Irrigation System: System is in place but is only used on an as-needed basis.

Frost Control Methods: None.

Harvesting Methods: Manlifts are used for sanitation picking. Filled-seed percentages are then estimated, then seed cones are aborted (often sold for decorative purposes).

Special Problems: None.

Research Needs / Studies Underway: Studies testing effects of cytokinin sprays inhibiting conelet abortion. Assessment of bi-monthly sugar pine fertilization for control of conelet abortion. Also testing the effects of esfenvalerate on Western white pine conelet abortion.

PROGRAM/BREEDING ZONE:	F13,17-21,23	F14 & 16	F15 & 16
ORCHARD INFORMATION			
Species	WWP	WWP	SP
Age	3-25	10-30	20-25
# Clones/Families	504	260	220
Material Type	FS/HS	grafts	grafts
Orchard Acreage	13	30	9
Tree Spacing:			
Initial			
Current			
Final	24x24	24x24	24x24
Design	random	random	random
Seed Production:			
1980	0/0	69/777	0/0
1981	0/0	242/1300	0/0
1982	0/0	113/761	0/0
1983	0/0	274/1194	0/0
1984	0/0	19/405	52 cones
1985	0/0	421/1792	24/700
1986	0/0	??/995	??/175
1987	0/0	??/468	0/0
1988	0/0	??/2580	??/100
1989	?	?	?
Target #/year	475	1100	1180
Roguing Dates:			
First	ongoing	ongoing	ongoing
Next			
Replacement Date			
GENETIC TEST INFORMATION	**SEE NOTES		
# of Tests			
Test Age			
# of Genotypes			
Test Type			
Last Measured			

**Genetic testing on wind-pollinated and controlled-cross progeny of selected wild 5-needle pines has continued since 1966. Genetically identified progeny grown here are inoculated with blister rust basidiospores and screened over 5 years for a variety of horizontal and vertical resistance mechanisms. Families are grouped into hazard-use classes on the basis of identified mechanisms.

Grafts from resistant families are outplanted in Dorena's seed orchards and in 19 on-site seed orchards on NF land in different breeding zones throughout OR & WA, incorporating different lines of resistance and as broad a genetic base as possible.

Approximately 5,200 white pine selections have been screened for rust resistance; 1,540 resident families have been identified so far. An additional 3,900 sugar pines have been tested; 1,250 families have shown rust resistance.

Planning is underway for developing evaluation plantations to test growth/form traits of rust-resistant families. Long-term rust resistance will also be assessed in these tests.

Species: Douglas-fir

Year Initiated: 1982

Size (acres)
Gross: 700
Net: 420

Manager: Fred Borchert

Address: P.O. Box 121
Lorane, OR 97451

Phone: (503) 683-6445

Location: 12 miles west of Cottage Grove, OR.
Legal Description: Sections 9, 15, & 21, T.20 S. R.5 W., W.M.
Elevation: 700-1200'

Orchard Seed will be Used by the Following Organizations, Ranger Districts, Work Units, etc.: Eugene, Coos Bay, Roseburg Districts of the BLM.

Seedzones Represented by this Material: 071, 072, 252, 262, 270, 481, 491, and 492.

Acreage to be Reforested with Orchard Seed: 800,000.

Will Surplus Seed be Available for Sale? If so, when? (include contact person if different from above) Possibly - contact person is District Geneticist Rich Kelly.

Has this Orchard been Certified by an Appropriate State Seed Certification Agency? If not, will it be? No.

CULTURAL PRACTICES

Vegetation Management and Cover Crops: A low-growing fescue cover crop has been established. Vegetation around trees is controlled by mulching. Herbicides will be used when available.

Fertilization: Soils are deficient in phosphorus - this is applied during site preparation. Fescue cover crop is fertilized with nitrogen for 1-2 years until well established.

Cone and Pollen Stimulation Techniques: Orchards will be stimulated for cone and pollen production in both the breeding and production orchards.

Supplemental Mass Pollination: n/a.

Problem Cone and Seed Insects: n/a.

Insect Control Methods: Grafts are being sprayed with Lindane insecticide for control of Dioryctria damage.

Orchard Inventory / Monitoring System: Rootstock are inventoried in the Fall to determine "graftability."

Records/Database Management System: Orchard data are managed with "Revelation" database system on a Wyse 386 IBM-compatible computer. Field data are collected with a handheld Polycorder.

Irrigation System: None.

Frost Control Methods: n/a.

Harvesting Methods: n/a.

Research Needs / Studies Underway: Rootstock establishment and pollen flight studies are being conducted. Weather data are collected with a CR-21 (Campbell Scientific) weather station.

PROGRAM/BREEDING ZONE:	Gold Beach	Powers	S. Umpqua 1	S. Umpqua 2	S. Umpqua 3 & 6
ORCHARD INFORMATION					
Species	DF	DF	DF	DF	DF
Age	grafts	planned	0	0	planned
# Clones/Families	100	100	180	180	300
Material Type	grafts	grafts	RS	RS	grafts
Orchard Acreage	15	17	27	14	15
Tree Spacing:					
Initial	20x20	20x20	20x20	20x20	20x20
Current	20x20	n/a	20x20	20x20	n/a
Final	40x40	40x40	40x40	40x40	40x40
Design	random	random	RCB	RCB	RCB
Seed Production:					
1980	0/0	0/0	0/0	0/0	0/0
1981	0/0	0/0	0/0	0/0	0/0
1982	0/0	0/0	0/0	0/0	0/0
1983	0/0	0/0	0/0	0/0	0/0
1984	0/0	0/0	0/0	0/0	0/0
1985	0/0	0/0	0/0	0/0	0/0
1986	0/0	0/0	0/0	0/0	0/0
1987	0/0	0/0	0/0	0/0	0/0
1988	0/0	0/0	0/0	0/0	0/0
Target #/year	26	31	81	42	45
Roguing Dates:					
First	2007	2011	1996	1999	1993[a]
Next	2016	2020	2001	2004	1998
Replacement Date	2027	2031	2020	2021	2025
GENETIC TEST INFORMATION					
# of Tests	33	20	10	10	20
Test Age	13	7	9	6	11
# of Genotypes	937	420	360	360	690
Test Type	OP	OP	OP	OP	OP
Last Measured	1988	1986	1985	1988	1988

PROGRAM/BREEDING ZONE:	N.Umpqua 1	N.Umpqua 2	N.Umpqua 3	N.Umpqua 4 & 5	N.Umpqua 6 S.McKenzie 2
ORCHARD INFORMATION					
Species	DF	DF	DF	DF	DF
Age	0	0	planned	planned	planned
# Clones/Families	195	90	195	300-350	75
Material Type	RS	RS	grafts	grafts	grafts
Orchard Acreage	11	11	10	12	10
Tree Spacing:					
Initial	20x20	20x20	20x20	20x20	20x20
Current	20x20	20x20	n/a	n/a	n/a
Final	40x40	40x20	40x20	40x40	40x40
Design	RCB	RCB	RCB	RCB	RCB[b]
Seed Production:					
1980	0/0	0/0	0/0	0/0	0/0
1981	0/0	0/0	0/0	0/0	0/0
1982	0/0	0/0	0/0	0/0	0/0
1983	0/0	0/0	0/0	0/0	0/0
1984	0/0	0/0	0/0	0/0	0/0
1985	0/0	0/0	0/0	0/0	0/0
1986	0/0	0/0	0/0	0/0	0/0
1987	0/0	0/0	0/0	0/0	0/0
1988	0/0	0/0	0/0	0/0	0/0
Target #/year	33	33	30	36	11
Roguing Dates:				c	
First	2001	2000	1994[a]		2004
Next	2006[d]	2005[d]	1999	?	2010
Replacement Date	2021[e]	2021[e]	2020	2025	2017
GENETIC TEST INFORMATION					
# of Tests	11	7	9	21	6
Test Age	5	6	11	11	10
# of Genotypes	390	180	390	730	280
Test Type	OP	OP	OP	OP	OP
Last Measured	1989	1988	1988	1988	1989

PROGRAM/BREEDING ZONE:	S.McKenzie	N.McKenzie	Wells Crk.	Coquille 16	Coquille 17
ORCHARD INFORMATION					
Species	DF	DF	DF	DF	DF
Age	0	graft in '91	2	0	0
# Clones/Families	100	100	105	100	100
Material Type	RS	grafts	grafts	RS	grafts
Orchard Acreage	32	32	16	22	37
Tree Spacing:					
Initial	20x20	20x20	20x20	20x20	20x20
Current	20x20	20x20	20x20	20x20	20x20
Final	40x40	40x40	40x40	40x40	40x40
Design	RCB[b]	RCB[b]	random	random	random
Seed Production:					
1980	0/0	0/0	0/0	0/0	0/0
1981	0/0	0/0	0/0	0/0	0/0
1982	0/0	0/0	0/0	0/0	0/0
1983	0/0	0/0	0/0	0/0	0/0
1984	0/0	0/0	0/0	0/0	0/0
1985	0/0	0/0	0/0	0/0	0/0
1986	0/0	0/0	0/0	0/0	0/0
1987	0/0	0/0	0/0	0/0	0/0
1988	0/0	0/0	0/0	0/0	0/0
Target #/year	58	56	24	38	67
Roguing Dates:					
First	2004	2004	2005	2008	2007
Next	2010	2010	2014	2016	2015
Replacement Date	2017	2017	2025	2028	2027
GENETIC TEST INFORMATION					
# of Tests	10	10	8	8	8
Test Age	10	10	16	13	12
# of Genotypes	280	300	210	360	280
Test Type	OP	OP	OP	OP	OP
Last Measured	1989	1989	1988	1986	1987

PROGRAM/BREEDING ZONE:	Tyee 1	Tyee 2	Noti	Swisshome/ Mapleton	Lorane
ORCHARD INFORMATION					
Species	DF	DF	DF	DF	DF
Age	0	graft in '91	2	2	graft in '91
# Clones/Families	180	105	100	100	80
Material Type	RS	RS	grafts & RS	grafts & RS	grafts
Orchard Acreage	14	12	24	32	22
Tree Spacing:					
Initial	20x20	20x20	20x20	20x20	20x20
Current	20x20	20x20	20x20	20x20	n/a
Final	40x40	40x40	40x40	40x40	40x40
Design	RCB	RCB	RCB[b]	RCB[b]	RCB[b]
Seed Production:					
1980	0/0	0/0	0/0	0/0	0/0
1981	0/0	0/0	0/0	0/0	0/0
1982	0/0	0/0	0/0	0/0	0/0
1983	0/0	0/0	0/0	0/0	0/0
1984	0/0	0/0	0/0	0/0	0/0
1985	0/0	0/0	0/0	0/0	0/0
1986	0/0	0/0	0/0	0/0	0/0
1987	0/0	0/0	0/0	0/0	0/0
1988	0/0	0/0	0/0	0/0	0/0
Target #/year	42	36	44	51	29
Roguing Dates:					
First	1996[a]	1993[a]	2000	2000	2005
Next	2001	1998	2006	2006	2011
Replacement Date	2025	2021	2013	2013	2018
GENETIC TEST INFORMATION					
# of Tests	10	10	8	7	6
Test Age	8	11	18	18	9
# of Genotypes	360	210	330	270	240
Test Type	OP	OP	OP	OP	OP
Last Measured	1986	1988	1986	1986	1985

Species: Douglas-fir

Year Initiated: 1966

Size (acres)
Gross: 281
Net: 51

Manager: Don Dotter

Address: 16014 Pletzer Rd. SE
Turner, OR 97392

Phone: (503) 327-2212

Location: 10 miles northeast of Albany, OR.
Legal Description: Sections 4 & 9, T.10 S. R.2 W., W.M.
Elevation: 180'

Orchard Seed will be Used by the Following Organizations, Ranger Districts, Work Units, etc.: Weyerhaeuser and outside sales.

Seedzones Represented by this Material: Oregon seedzones.: 070, 071, 072, 252, 422, 442, 461, 472, 481, and 491; Washington seedzones: 030, 041, 241, 411 and 412.

Acreage to be Reforested with Orchard Seed: 2.4 million.

Will Surplus Seed be Available for Sale? If so, when? (Include contact person if different from above) Seed is available now. Contact Terry Smith at (206) 924-3292 or Richard Hankinson at (206) 924-2547.

Has this Orchard been Certified by an Appropriate State Seed Certification Agency? If not, will it be? Yes.

CULTURAL PRACTICES

Vegetation Management and Cover Crops: Mow fawn fescue grass between tree rows. Spray tree rows with herbicides.

Fertilization: Minimal adjustments, indicated by results of soil/foliar analyses.

Cone and Pollen Stimulation Techniques: Alternating-year basis with double overlapping girdles + calcium nitrate applied at 200# N/acre. Gibberellins are used as needed to meet seed needs. Breeding work involved gibberellins and girdling.

Supplemental Mass Pollination: On select clones to increase genetic gain.

Problem Cone and Seed Insects: Gall midge, chalcid, Dioryctria, and seed bug.

Insect Control Methods: Dimethoate, Pydrin, and Omite via air blast sprayer. Aerial spraying is occasionally used.

Orchard Inventory / Monitoring System: Monitoring involves clonal quality analysis, reproductive phenology, cone and orchard efficiency, crop estimates, and insect populations.

Records/Database Management System: Mainframe accessible via PC. Software programs include D:Base and Lotus 1-2-3.

Irrigation System: Under-tree and drip systems.

Frost Control Methods: Under-tree irrigation and helicopters.

Harvesting Methods: Manlifts, ladders, climbers, and tree shaker/filbert sweeper.

Special Problems: Gall midge, spider mites, flower abortion, and trees which respond poorly to flower stimulation.

Research Needs / Studies Underway: Flower stimulation of recalcitrant clones. Better understanding of nutritional needs of heavily flowering trees.

PROGRAM/BREEDING ZONE:[a] Elevation	Coos Bay Low	Coos Bay High	Springfield Low	Springfield High
ORCHARD INFORMATION				
Species	DF	DF	DF	DF
Age	21	15	20	14
# Clones/Families	121	50	120	50
Material Type	grafts	grafts	grafts	grafts
Orchard Acreage	14.3	1.4	13.7	5.3
Tree Spacing:				
Initial	10x24	15x25	10x24	15x25
Current	variable	variable	variable	variable
Final	same	same	same	same
Design	random	random	random	random
Seed Production:				
1980	146/370	0/0	133/333	0/0
1981	6/31	0/0	4/23	0/0
1982	139/354	0/0	62/174	0/0
1983	28/153	0/0	12/61	0.5/3
1984	207/819	8/26	85/306	2/11
1985	64/175	6/25	27/118	3/13
1986	799/1453[b]	62.9/265[b]	818/1537[b]	2/7
1987	9/35[c]	0.2/1	12/65	145/208
1988	125/369[c]	0/0[d]	88/249[c]	0/0[d]
Target #/year	140	14	135	55
Roguing Dates:				
First	1981, '83, '87, '88, '89			
Next	ongoing as genetic information becomes available			
Replacement Date	replaced by 2nd generation orchards by the year 2005			
GENETIC TEST INFORMATION	Combined Testing		Combined Testing	
# of Tests	70		90	
Test Age	17		16	
# of Genotypes	469		367	
Test Type	86% DOX, 14% SPM/PMX/OP			
Last Measured	1989		1989	

Additional Comments:

[a] 2000' elevational split

[b] Stimulated crop

[c] Selective harvest from only top-ranked clones

[d] Unharvested crop

PROGRAM/BREEDING ZONE:	Longview[a]	Twin Harbors	Vail	Cascade[a]
Elevation	Low	Low	High	Mid
ORCHARD INFORMATION				
Species	DF	DF	DF	DF
Age	15	15	15	14
# Clones/Families	50	50	50	50
Material Type	grafts	grafts	grafts	grafts
Orchard Acreage	9.5	1.9	2.8	2.1
Tree Spacing:				
Initial	15x25	15x25	15x25	15x25
Current	variable	variable	variable	variable
Final	same	same	same	same
Design	random	random	random	random
Seed Production:				
1980	0/0	0/0	0/0	0/0
1981	0/0	0/0	0/0	0/0
1982	0/0	3/11	0/0	0/0
1983	1/7.5	0.2/3	0/1	0/0
1984	3/20	0.6/4	3/12	0.6/10
1985	19/60	13/26	7/21	1/3
1986	14/46	82/170[b]	6/26	2/7
1987	213/396[c]	2/5	172/368[b]	19/40[b]
1988	0/0[d]	12/34[c]	0/0[d]	0/0[d]
Target	95	20	30	20
Roguing Dates:				
First	1981, '83, '87, '88, '89			
Next	ongoing as genetic information becomes available			
Replacement Date	replaced by 2nd-generation orchards by the year 2005			
GENETIC TEST INFORMATION				
# of Tests	49	37	38	47
Test Age	13	14	17	13
# of Genotypes	346	270	223	333
Test Type	86% are DOX, 14% are SPM/PMX/OP			
Last Measured	1989	1989	1989	1989

Additional Comments:

[a] Combined information form low/high elevation programs

[b] Stimulated crop

[c] Selective harvest from only top-ranked clones

[d] Unharvested crop

SECTION 3

THIRD REPORT

National Steering Committee for Application of Pesticides - Western Defoliators

January 30, 1991

USDA Forest Service
Washington Office/Forest Pest Management
2121 C 2nd Street
Davis, CA 95616
(916)758-4600
FTS 460-1715

CONTENTS

I. INTRODUCTION

The third meeting of the National Steering Committee for Application of Pesticides - Western Defoliators met in Salt Lake City, Utah, November 6, 1990. The meeting was held in conjunction with the National Steering Committee for Application of Pesticides - Gypsy Moth and Eastern Defoliators.

A. Committee Members

J. Robert Bridges	WO/FIDR (Washington, DC)
Jesus Cota	WO/FP (Washington, DC)
John Cunningham	Forest Pest Management Institute (Sault Ste. Marie, Ontario)
Gary Daterman	PNW/FIDR (Corvallis, OR)
Kees van Frankenhuyzen 1.	Forest Pest Management Institute (Sault Ste. Marie, Ontario)
Ladd Livingston	Idaho Department of Lands (Coeur D'Alene, ID)
John Neisess	R-5(RO)FPM (San Francisco, CA)
Max Ollieu	R-6/FPM (Portland, OR)
Iral Ragenovich	R-6(RO)FPM (Portland, OR)
Pat Shea	PSW/FIDR (Davis, CA)
Larry Stipe	R-1(RO)TM (Missoula, MT)
Julie Weatherby	R-4(BFO)FPM (Boise, ID)
Jack Barry (Chairperson)	WO/FPM (Davis, CA)

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1. Absent

B. Other Participants

Dave Bridgewater	R-6/FPM (Portland, OR)
Leo Cadogen	Forest Pest Management Institute (Sault Ste. Marie, Ontario)
Harold Flake	R-8/FPM (Atlanta, GA)
Michelle Frank	NA/FPM (Durham, NH)
Tom Hofacker	WO/FPM (Washington, DC)
Dave Holland	R-4/FPM (Ogden, UT)
Win McLane	USDA/APHIS (Otis AFB, MA)
Mike McManus	NES/FIDR (Hamden, CT)
Dick Reardon	NA/AIPM (Morgantown, WV)
Jessie Rios	California Department of Forestry (Sacramento, CA)
Harry O. Yates III	SEFES/FIDR (Athens, GA)

These participants were encouraged to share with the committee their concerns and needs related to managing gypsy moth.

C. Purpose of Steering Committee

The purpose of the steering committee is to analyze, identify, and recommend field and pilot testing needs for application of pesticides to manage western defoliators. Needs include those associated with pesticides, application systems, techniques, and strategies that influence the USDA Forest Service's (FS) and and State cooperator's ability to use pesticides safely, effectively, and in an economically, and environmentally acceptable manner.

D. Operating Guidelines

The committee expanded its scope as reflected in paragraph C above, to include use of ground application of pesticides to manage insects

that defoliate western forests. The committee will also serve, at the request of the Director, Forest Pest Management, as a panel to review national technology project proposals that relate to western defoliators. Additional operating guidelines adopted at the previous committee meeting are as follows:

1. Emphasize cooperation between FIDR and FPM especially in planning and conducting field projects.

2. Emphasize the need to field test new strains of *Bacillus thuringiensis* (B.t.) and not the HD-1 strain. The HD-1 strain has been adequately tested by FIDR; however, unique or unusual changes to HD-1 or its carrier may qualify it for testing.

3. Maintain the traditional approach to field testing and pilot projects.

4. Encourage thorough and timely reporting of field tests and pilot project results.

5. Facilitate cooperation with industry and encourage their development and testing of microbials.

6. Seek ways to reduce costs of field tests and pilot projects, and to encourage industry to share costs.

7. Maintain this steering committee.

E. Reports to the Committee

Reports delivered to the Committee by members and other participants are contained in the Appendix.

II. CURRENT RECOMMENDATIONS

Current recommendations are primarily recommendations carried forward from the previous meeting. Recommendations are listed in order of priority with No. 1 being the highest priority followed by the organization that the committee recommends as the lead to initiate action.

A. Laboratory and/or Investigations

1. **Pursue laboratory testing of new Bacillus thuringiensis (B.t.) strains.**

   New strains of B.t. that may have significantly higher efficacy against western defoliators should be tested in the laboratory in cooperation with industry, e.g. Novo and Abbott.

   PNW

2. **Develop a plan to obtain data on impact of B.t. on non-target organisms.**

   There is only limited information in this area and the committee recommends that a plan be developed by PNW to obtain these data. The plan would include field inventory, laboratory evaluations, field testing, and methods to fund and accomplish this work.

   PNW

3. **Explore techniques for rapid bio-assay of B.t.**

   ELISA (enzyme link immunosorbant assay) techniques are needed for rapid bio-assay of B.t. in the field. Capabilities exist at University of California, Davis (UCD) and Entotech, Inc., (Novo),

Davis, CA. The committee recommends that a proposal be prepared and funds be made available with Pat Shea taking the lead.

PSW

4. **Develop, identify, and evaluate improved carriers for TM Biocontrol-1.**

The current tank mix of field grade molasses, Orzan LS, and water handled well during January 1991 airport trails at Davis, CA. Atomization from Micronair atomizers and flat fan nozzles appeared to be excellent; however data are still being evaluated. Product Coordinators (Jim Hadfield for TM Biocontrol-1 and Dick Reardon for Gypchek) are cooperatively developing a 5-year plan that will lead to operational use of these insecticides. Investigating improved carriers and cooperation with Canada on carrier development should be part of the plan. The committee also recommends that the product managers seek cooperation from the private sector in developing improved carriers, especially Gypchek carriers as the potential use of Gypchek far exceeds that of TM Biocontrol-1.

R-6
NA
PNW

5. **Determine evaporation rates and physical properties of microbial tank mixes.**

MTDC is soliciting for a contractor to determine evaporation rates and physical properties of pesticide tank mixes used by the FS. Rates will be determined as funds are available; however MTDC should request funding pursuant to this recommendation.

MTDC

B. Field Tests

1. Field test TM Biocontrol-1 including lower doses, and with improved carriers as they become available. Priority is given to testing methods of controlling Douglas-fir Tussock Moth (DFTM) as the insect is in current outbreak.

   PNW

2. Conduct mating disruption tests using pheromones against western spruce budworm.

   PNW

3. Conduct cooperative field tests of several dosages (0.5, 1, and 2 ounces per acre) of Dimilin against DFTM and study non-target effects compared to non-target effects of B.t.

   PSW

C. Pilot Projects and Cooperative Field Tests/Pilot Projects

1. Conduct cooperative pilot test of TM Biocontrol-1, double (spring and summer treatments) against new, low level, and sub-outbreaks of DFTM.

   PNW

2. Conduct mating disruption tests using pheromones against DFTM.

   PNW
   R-4
   R-6

3. Conduct cooperative field tests/pilot tests of new strains of B.t. against western spruce budworm as they are recommended by PNW (Project 4502).

PNW
R-6

4. Conduct pilot test of B.t. against new and low level outbreaks of DFTM.

R-6

5. Conduct pilot test of Dipel 8L and Dipel 8AF applied at 32 ounces per acre to control western spruce budworm.

Abbott Laboratories

D. Equipment, Models, and Technology Development.

1. Evaluate the utility of the computer model Computer Assisted Spray Productivity Routine (CASPR) on a pilot or operational project.

R-4
WO/FPM
MTDC

2. Evaluate existing aircraft guidance systems and provide recommendations for operational deployment.

MTDC

3. Evaluate and recommend methods of sampling ultra low volume (ULV) sprays on pilot and operational projects.

MTDC

4. **Update and add spray nozzle specification data to the Program WIND aerial application equipment handbook.**

MTDC

5. **Determine physical properties and drag coefficients of substances.**

MTDC

6. **Coordinate complex terrain modeling with Global Positioning System (GPS), Geographic Information Systems (GIS), and expert system activities being developed by the FS.**

MTDC

E. Information and Administrative Management

1. **Plan and conduct multi-year monitoring, analyses, and data management of spray treatments.**

R-3
R-4
R-5
R-6

The data and information are needed for cost/benefit analyses by resource managers. We need to know duration of carryover benefits of treatments and tree growth information. Even short term benefits of treatment cannot be determined during the first year of treatment. For cost/benefit information and other economic analysis, the benefits or lack of benefits over 3 to 5 year periods should be established and recorded. This includes the R-6 Meacham Pilot Project conducted in 1988. Monitoring during 1989 shows that the benefits of treatment were carried over from 1988 to 1989. Monitoring the R-3 Jemez Mountain

control project showed that the western spruce budworm was kept suppressed for 5 years. This is valuable information in developing control strategies and in calculating cost/benefits for future control operations.

2. **Develop guidelines for conduct of wind tunnel and airport spray characterization trials.**

WO/FPM

3. **Pursue microbial research.**

WO/FIDR
WO/FPM
PNW

The committee recommends maintaining and increasing support of microbial and pheromone research for improved pest monitoring and suppression.

4. **Evaluate and revise current standards for determining successful control.**

FIDR/WO
FPM/WO

5. **Registered B.t. formulations.**

Currently registered B.t. products for DFTM and western spruce budworm, and their respective undiluted application rates for 16 BIU's per acre are listed below.

Product	Application Rate	Registration DFTM[1.]	WSBW[2.]
Thuricide 32LV	64 oz	X	X
Thuricide 48LV	43 oz	X	X
SAN 415	64 oz	X[3.]	X[3.]
Dipel 6L	43 oz	X	X
Dipel 8L	32 oz	X	X
Dipel 6AF	43 oz	X[3.]	X[3.]
Dipel 8AF	32 oz	X[3.]	X[3.]
Foray 48B	43 oz	X[3.]	X[3.]

1. DFTM = Douglas-fir tussock moth.
2. WSBW = Western spruce budworm
3. Not registered for forestry use in California.

6. **The committee strongly endorses assignment of Product Coordinators for TM Biocontrol-1 and Gypchek.**

7. **The committee expresses concern over apparent failure of the DFTM pheromone early warning system to detect DFTM build-up in Idaho.**

III. STATUS OF PREVIOUS RECOMMENDATIONS

Status of previous committee recommendations is summarized below.

A. Laboratory and/or Field Investigations

1. Pursue laboratory evaluation of new B.t. strains.

   PNW

   No new strains were evaluated.

2. Develop a plan to obtain data on impact of B.t. on non-target lepidoptera.

   PSW
   PNW

   The committee recommended that PSW and PNW join to obtain data on impact of B.t. on non-target leptidoptera. This was not accomplished.

3. Develop, identify, and evaluate improved carriers for TM Biocontrol-1.

   PNW
   R-6

   Jim Hadfield, R-6, has been designated TM Biocontrol-1 product coordinator and is cooperating with Roy Beckwith. Jim's charge includes field evaluation of tank mixes. Tests will be conducted in early 1991 at the University of California, Davis wind tunnel to investigate atomization and influence of physical properties. Also, airport trials were conducted at Davis, CA to evaluate mixing, handling, and atomization of TM Biocontrol-1 and Gypchek. Results of these tests are being evaluated.

4. Explore techniques for rapid bio-assay of microbials.

PSW

Pat Shea has discussed with Bruce Hammock, University of California, Davis (UCD), the feasibility of using an enzyme link immunosorbant assay (ELISA) method of determining B.t. potency. The next step is to pursue funding and establish a cooperative project at UCD.

5. Determine evaporation rates and physical properties of microbial tank mixes.

WO/FPM

Bob Ekblad, MTDC, has prepared an RFP to contract a facility to measure evaporation rates and proposal responses will be reviewed in March. Physical properties of tank mixes are being measured at UCD for selected biological tank mixes.

6. Obtain spreadfactors for all micorbial tank mixes.

WO/FPM

The U.S. Army, Aberdeen Proving Ground, was contracted to evaluate B.t. spreadfactors on deposit papers. FPM (Davis) Report 90-8, Spectroscopically Derived Spreadfactors for Different Bacillus thuringiensis Insecticidal Formulations on Paper Impaction Cards. The report discusses utility of kromekote as an impaction surface and provides spreadfactors for Foray 48B and Thuricide 32 LV. Additionally Alam Sundaram and Errol Caldwell (FPMI) have been contacted about doing spreadfactors work for the FS. The latter is still under discussion. The pesticide laboratory at Pennsylvania State University determines spreadfactors for microbials and should be contacted for

spreadfactor information. Recommend that industry be encouraged to provide spreadfactors for their products using standardized methology.

B. Field Tests

1. Conduct field tests of new strains of B.t. against western spruce budworm as recommended.

   PNW

   No field tests were conducted in 1990 and none scheduled until 1992.

2. Conduct field tests of improved tank mixes of TM Biocontrol-1.

   PNW

   No tests due to lack of a qualifying population.

3. Conduct mating disruption tests using pheromones against western spruce budworm and (DFTM) outbreaks.

   PNW
   R-4

   Julie Weatherby and Lonnie Sower are cooperating on mating disruption test of DFTM moth on 200-500 acre blocks. PNW is planning DFTM test scheduled in 1991.

4. Conduct field experiments of Sandoz Crop Protection Corporation (Sandoz) product SAN 415 SC 32LV (NRD-12 strain, 32 BIU per gallon) against DFTM to obtain efficacy data.

   PNW

No field experiment was conducted and Sandoz has not demonstrated an interest in supporting forest spraying with SAN 415.

5. Conduct field experiments of lower doses of TM Biocontrol-1.

PNW

No field experiments were conducted as there were no test populations in the Northwest. A dosage rate test is scheduled in 1991.

6. Conduct cooperative field tests of several dosages (0.5, 1, and 2 ounces per acre) of Dimilin against DFTM in California.

PSW

No field tests were conducted as there were no test populations in California.

C. Pilot Projects and Cooperative Field Tests/Pilot Projects

1. Conduct cooperative pilot test of the Sandoz B.t. product SAN 415 against western spruce budworm.

PNW

No test of SAN 415 was conducted.

2. Conduct cooperative pilot test of TM Biocontrol-1, double (spring and summer treatments) against new, low level, and sub-outbreaks of DFTM.

PNW

No cooperative test of TM Biocontrol-1 was conducted.

3. Conduct pilot test of B.t. against new and low level outbreaks DFTM.

PNW

No test of B.t. was conducted against low levels of DFTM.

4. Conduct pilot test of Dipel 8L and Dipel 8AF applied at 32 ounces per acre to control western spruce budworm.

Abbott Laboratories

No test of low rates of Dipel 8L or Dipel 8AF were conducted.

D. Equipment, Models, and Technology Development

1. Conduct airport spray trails to characterize Dipel 6AF.

WO/FPM

Aircraft characterization trails of Dipel 6AF were conducted by WO/FPM (Davis), R-6/FPM and Abbott Laboratories at Marysville, CA in 1990 and results reported.

2. Evaluate and recommend methods of sampling ultra low volume (ULV) sprays on pilot and operational projects.

MTDC

No work was initiated.

3. Evaluate existing aircraft guidance systems and provide recommendations for operational deployment.

MTDC

MTDC has been asked to develop a proposal to address this recommendation.

4. Evaluate the utility of the computer model Computer Assisted Spray Productivity Routine (CASPR) on a pilot or operational project.

MTDC

Steve Munson (R-4) used CASPR to plan the 1990 R-4/Utah gypsy moth project. Evaluation of CASPR will be continued in 1991 on the R-4/Utah project.

5. Update reference reports on atomization of current pesticide tank mixes.

WO/FPM

WO/FPM (Davis) has published and distributed an update reference on atomization of pesticide tank mixes.

6. Update and add spray nozzle specification data to the Program WIND aerial application equipment handbook.

MTDC

MTDC has not initiated action on this recommendation.

7. Coordinate complex terrain modeling with Global Positioning System (GPS), GIS, and expert system activities being developed by the FS.

MTDC

WO/FPM (Davis), MTDC, and MAG met to discuss these needs and a feasibility report was prepared by FPM. Also, two meetings have

been held with EPA at Las Vegas to plan cooperative activities that include geographical and visualization techniques with EPA. An EPA/FS workshop is scheduled for June 1991. MTDC has a contract with Battelle to adopt a complex terrain model to FPM needs. Bob Ekblad prepared two status reports to the FPM technology task groups in August 1990. The project is progressing well.

8. Determine physical properties and drag coefficients of substances.

MTDC

MTDC has not initiated action on this proposal.

E. Information Management

1. Plan and conduct multi-year monitoring, analyses, and data management of spray treatments.

R-3
R-4
R-5
R-6

No action has been initiated.

2. Publish a reference and maintain a Data General computer data base on western defoliator aerial spray projects.

WO/FPM

WO/FPM (Davis) in cooperation with R-4/FPM has compiled and distributed a report entitled <u>Aerial Insecticide Projects for Suppression of Western Defoliators: 1970-1989 - An annotated Bibliography</u>.

F. Administrative

1. Guidelines for Field tests and Pilot Projects

   a. **Guidelines have been finalized and incorporated in the FS Handbook.**

   b. **No other guidelines have been prepared.**

2. West-wide EIS for DFTM.

   This was not done and committee does not believe it is necessary as EA's seem to accommodate this need.

3. Testing of NOVO's Foray 48B.

   The committee had suggested that NOVO pilot test Foray 48B. In that the material was pilot tested in 1990 a pilot test becomes somewhat academic.

IV. SUMMARY

The National Steering Committee for Application of Pesticides - Western Defoliators met in Salt Lake City, Utah, November 6, 1990. The April 1990 committee meeting recommendations were reviewed and discussed. Some progress on the recommendations has been made; however, the committee noted that progress is slow on most of the high priority recommendations. At the meeting previous recommendations were updated, expanded, and priorities changed as appropriate. The next meeting is proposed for early July 1991.

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APPENDIX

REPORT TO WESTERN DEFOLIATOR STEERING COMMITTEE MEETING, November 6-8, 1990.
G. Daterman, PNW-Station.

1990 ACTIVITIES:

1. R. Beckwith and D. Grimble have been evaluating a modified spray formulation for the DFTM virus (TM BioControl-1). Laboratory results are very good, but there is a need for testing the material in aircraft spray apparatus.

2. Field testing of trap design and modified lures for monitoring DFTM populations with pheromone-baited traps indicate that the standard (0.001%) pvc lure could be used in a commercially-available "USDA" trap for operational monitoring. This would simplify the process in comparison to the current use of the "milk-carton" trap. The Phero Tech lure was again compared in the field and found to be much improved in calibration of its release rate of pheromone (for avoiding premature trap saturation).

3. Western spruce budworm monitoring for prediction of defoliation levels was again conducted in Regions 1,2, and 6. Results were not available at the time this report was prepared. The PNW lead scientist for this work, C. Sartwell, retired September 28, 1990, but has assured Daterman that he will prepare a report and manuscript on the effectiveness of this technique.

4. Laboratory research on phytochemicals as feeding deterrents has turned up some promising leads for certain extracts and isolated compounds as effective feeding deterrents of the western spruce budworm and the gypsy moth. From a practical viewpoint, these materials would likely be useful for protection of ornamentals, rare (threatened and endangered spp) plants, nurseries, etc. Work is continuing on development of specific compounds.

1991 PlANS:

1. PNW/R6 has a joint proposal for Special Project Funding to evaluate a Mycogen Co. (San Diego, Calif.) set of BT strains and formulation against western spruce budworm. The proposal specifies screening tests in 1991 and field testing in 1992. R.Beckwith and D.Grimble are the PNW participants.

2. The upsurge of DFTM in NE Oregon and southern Idaho has prompted discussion and planning for field testing of lower dosages and new spray formulations for the nuclear polyhedrosis virus (TM BioControl-1). The dosage test would compare 1/4 and 1/2 dosages to the recommended label dose. Formulations would include comparisons of the Espro Co. modified molasses preparation to the label standard. Other promising candidate formulations should also be evaluated. This effort could be a combination field and pilot test project, with test variables evaluated appropriately between the respective efforts. R.Beckwith and D.Grimble are projected PNW participants.

3. The pending R4/R6 DFTM outbreak also prompted a study plan for pilot testing the pheromone mating disruption method of control for this pest. This

effort would be in cooperation with the appropriate Region, PNW, WO-FPM, and Scentry Inc. (Buckeye, Ariz.). Scentry and WO-FPM have been collaborating in their communications with the EPA to secure a 3-year EUP and eventually a full registration (for Scentry) for this control method on DFTM. Numerous past field tests have shown consistent efficacy for this technique on DFTM, and the the timing appears appropriate for a pilot test to evaluate operational feasibility and efficacy. L.Sower has prepared a draft study plan and would be the PNW participant.

4. Efforts to improve and further evaluate the pheromone-baited trap systems for monitoring DFTM and western spruce budworm will continue in 1991. This will include working with Phero Tech to refine and calibrate a commercial lure.

5. Research on feeding deterrents derived from plant extracts will also continue in 1991.

A Report to the USFS Joint Meeting of the National Steering Committee for Application of Pesticides - Western Defoliations, Gypsy Moth and Other Eastern Defoliations.

Salt Lake City, Utah 6th - 8th November 1990

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Research Activity: Impact and fate of insecticides in the envirolment.

Principal Researchers:

1. K.M.S. Sundaram - Distribution, Deposition and Persistance of _Bacillus thuringiensis_ (_kurstaki_) [_B_._t_.(k)] in a Deciduous Forest Enviroment.

Undiluted Novo Foray[R] 48B _Bacillus thuringiensis_ (k) formulation was sprayed in May 1990 over four blocks of a deciduous forest with oak stands in the Hawley area of eastern Pennsylvania at two dosage rates in duplicate at 20 BIU/53 US oz per acre (50 BIU/1.57 L per hectare) and 30 BIU/80 US oz per acre (75 BIU/2.37 L per hectare). Prespray and postspray oak foliage and simulated oak foliage samples were collected at intervals of time and stored in alkaline buffer with NaN_3 for assaying the concentration levels of _B_._t_.(k) (60 kilodalton, kDa) toxin. _B_._t_. deposits in ground samplers (glass-fiber discs mounted on collection units and alkaline buffers in petri-dishes) were also collected at 1h postspray. Droplet densities (droplets/cm^2) and droplet size distributions (NMD, VMD, D_{max} and D_{min}) were measured at canopy and ground levels using Ciba-Geigy water sensitive papers (10 mm x 26 mm) mounted or fastened onto supports.

Gypsy moth larvae were bioassayed (force feeding) against the alkaline buffer extract of the formulation (Novo Foray[R] 48B), and a calibration curve (% mortality _vs_ concn. of 60 kDa) was prepared. Pre- and postspray _B_._t_.(k) extracts of simulated and natural oak foliage) were bioassayed and the mortalities of the larvae determined. Using the calibration curve, the concentration of the 60 kDa _B_._t_.(k) in the analytes were established. The concentrations of the 60 kDa _B_._t_.(k) in different extracts were also quantified by using an enzyme-linked immunosorbent assay (ELISA) developed cooperatively by the author and Dr. D.B. Hammock (Univ. Calif., Davis, CA). The ELISA studies are in progress and involve the coating of the microtiter plates successively with goat anti _B_._t_.(k), addition of analyte [_B_._t_.(k) extract], addition of rabbit anti _B_._t_.(k), goat anti-rabbit IgG (enzyme labeled) and developing a yellow color for spectroscopic quantification with the addition of a substrate. Using the bioassay and ELISA data, the distribution and persistence of _B_._t_.(k) as 60 kDa will be evaluated. If efficacy data are made available, attempts will be made to correlate the residue levels with observed larval mortality.

Collaborative Research Areas:

The principal researcher will be pleased to interact with researchers interested in the above areas, _viz_; _B_._t_. deposit assessment, _B_._t_. quantification _via_ bioassay and ELISA and evaluation of the persistence and fate of _B_._t_. in a forest enviroment.

2. Stephen B. Holmes (Project Leader) and D.P. Kreutzweiser - Effects of B.t. on Non-Target Organisms.

B.t. is the most widely used forest pest control product in Canada. When it was still a minor component of forest spray programs, relatively little attention was paid to the environmental effects of B.t. Concern was focussed more on the chemical insecticides, such as fenitrothion, because these were perceived as being more damaging to the environment. Now, however, because of its increased use, B.t. is being looked at more closely.

At the Forest Pest Management Institute (FPMI), three studies that deal with the environmental impacts of B.t. spraying are underway. Each of these studies is described briefly below:

Toxicity of B.t. to Stream Insects

Relatively little has been published in the scientific literature on the toxicity of B.t.k. (Bacillus thuringiensis kurstaki) to aquatic insects. Eidt (1985) tested 9 taxa of aquatic insects, representing 4 major orders, Trichoptera, Plecoptera, Ephemeroptera and Diptera, for susceptibitliy to B.t. at concentrations of 4.3, 43 and 430 IU/mL under static conditions. The concentrations were chosen to represent a worst-case field situation, a 10X overdose and a 100X overdose, respectively. Only one species of blackfly was clearly affected by the B.t., and this was at the highest concentration. Although effects on other species were suggested, Eidt concluded that the risk to aquatic insects was low and that buffer zones were not required around water bodies for aerial spraying with B.t.k.

There are currently no buffer zones around standing water for aerial spraying with B.t. in Newfoundland, New Brunswick, Quebec and Ontario (Kingsbury and Trial 1987). Nova Scotia requires a 30 m setback for aerial spraying of all pesticides, including B.t. (Kingsbury and Trial 1987).

Recently, concern has been expressed by Environment Canada, Conservation and Protection, in British Columbia that the data base for B.t. is too limited to adequately assess the requirement for buffer zones around fishery sensitive streams. They suggest that further testing is needed, and that, until the information from these tests is available, a buffer zone of 10 m should be imposed.

In order to fill one of the data gaps identified by Environment Canada (i.e. the need for more comprehensive and reliable toxicity data), FPMI is conducting laboratory and field bioassays with B.t. and stream insects. The apparatus used in the laboratory tests is a flow-through design (Rodrigues and Kaushik 1984) that more closely simulates the natural stream environment than the static system of Eidt (1985). The initial test for each species is performed at 100X the expected environmental concentration (EEC) as calculated by the Department of Fisheries and Oceans Canada (i.e. 100 X 6 IU/mL). The total exposure and observation periods are 24 and 216 h, respectively. If a positive response is observed at this concentration, an additional test is conducted to determine the LC50. Field bioassays are performed in artificial stream channels. These tests concentrate on a sublethal response (i.e. induced drift) to the insecticide. The concentrations tested are arrived at in the same way as in the laboratory tests, except that an EC50 is calculated. The exposure and observation periods are 2.5 and 168 h, respectively. To date, 6 species

have been tested using this approach (*Heptagenia flavescens*, *Stenonema* sp., *Isonychia* sp., *Isogenoides* sp., *Acroneuria* sp., and *Hydropsyche* sp.), and no lethal or sublethal effects have been detected at 100X the EEC.

3. Principal Researcher: Kevin Barber - Relative Susceptibility to B.t. of Non-target Lepidoptera Larvae.

According to Dimond and Morris (1984), the larvae of 200 species of Lepidoptera are known to be susceptable to B.t.k. In addition, field studies have shown that B.t. spraying to control forest pests can signfficantly reduce populations of non-target Lepidoptera (Bendell 1986, Miller 1990). Lepidoptera are ecologically important because they function in food webs as herbivores and because they are a food resource for birds and other wildlife (Miller 1990). Lepidoptera are also esthetically valuable to amateur and professional naturalists and entomologists.

Studies at FPMI with B.t. and non-target Lepidoptera have focussed primarily on the caterpillar fauna of blueberry (*Vaccinium angustifolium*). These caterpillars are an important food resource for grouse, songbirds and small mammals in jack pine plantations. The relationship between B.t. spraying to control jack pine budworm and secondary effects on non-target wildlife was initially explored by J.F. Bendell of the University of Toronto (Bendell 1986, Innes and Bendell 1989), and some field work described below was conducted cooperatively with him.

In 1989, two 80 ha blocks of jack pine forest near Gogama, Ont. were aerially sprayed with B.t. Effects on blueberry leaf-feeding Lepidoptera were assessed in two ways: 1) larval populations were sampled by sweep netting along transects in treated and control areas, before and after spraying; and 2) field bioassays were conducted in which *Itame brunneata* (Lepidoptera: Geometriadae) larvae, one of the most abundant caterpillar species on blueberry at the time of treatment, were fed blueberry foliage collected from sprayed and unsprayed areas. Preliminary results suggest that caterpillar numbers were reduced on blueberry for up to 15 days after treatment. Results for individual taxa are not yet available. In the bioassays, mortality rates for *Itame brunneata* were in the range of 28-41%.

In addition to the studies described above, laboratory bioassay protocols are being developed for non-target Lepidoptera larvae. This includes establishment of laboratory cultures of important species. Attempts to rear *Itame brunneata* have met with only limited success so far. Better progress is being made with some other common species from blueberry (e.g. *Orthosia revicta* (Lepidoptera: Noctuidae)). In the laboratory bioassays, a number of dosing procedures are being investigated, including direct oral intubation and feeding of contaminated leaf disks and diet plugs.

Principal Researcher: R. Millikin - Secondary Effects of B.t. Spraying on Forest Songbirds.

Lepidoptera larvae are the preferred food for most breeding insectivorous forest birds (MacArthur 1958, Holmes and Schultz 1987), and are important for the growth and survival of the young of omnivorous species (Petersen and Best 1986, Johnson and Boyce 1989). By reducing the availability of caterpillar prey, B.t. spraying could indirectly affect forest birds.

In 1989, a study was conducted to determine the effect of B.t. spraying on the reproductive success of ground-nesting songbirds in jack pine plantations. This study took place in the same blocks as the caterpillar work described above. The methods used included singing-male censuses, observations of foraging behavior and feeding of young, collection of food samples from ligated nestling, determination of nestling growth rates and survival, and mist-netting of banded individuals.

The results are preliminary, but the following general observations can be made. Fewer food items were brought to hermit thrush young in the treated areas than in the control areas (4.8 versus 6.8 items/crop sample, respectively), and Lepidoptera larvae made up a significantly smaller component of the diet of treated nestlings (7% of food items versus 58% in control). These differences in diet did not translate into differences in growth rate or survival of nestlings (the probability of survival in the treated area was 0.40 and in the control was 0.23). The results were generally similar for other ground-nestling bird species (i.e. junco, white-throated sparrow and black and white warbler). Considering ground-nesting birds as a group, there was no significant difference in the proportion of young caught by mist-netting in the treated versus the control areas (21% and 25% of the total catch, respectively), or in the ratio of young to adult females. It is concluded that the observed reduction in caterpillar food resulting from the B.t. spray did not have a significant adverse effect on the growth or survival of young ground-nesting songbirds.

The studies described above are ongoing within the Environmental Impact Project of FPMI. David P. Kreutzweiser is responsible for aquatic toxicology studies, Kevin N. Barber for non-target Lepidoptera bioassays and Rhonda L. Millikin for forest songbird studies.

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Collaborative Research Areas: (Contact the project leader - S. Holmes)

1) Laboratory and field toxicity testing of forestry pesticides (hexazinone, trichlopyr and B.t.) on non-target aquatic invertebrates in flow-through systems.

2) Development of standardized methodologies to test the side-effects of pesticides on beneficial terrestrial arthropods. Establishing laboratory cultures of non-target Lepidoptera and conducting bioassays with B.t. and gypsy moth NPV.

3) Secondary effects of B.t. spraying on forest songbirds.

4) Development of microcosms to study the fate and environmental effects of microbial forest pest control products in the laboratory.

Research Activity: Control of Eastern Defoliations

Principal Researcher: A. Sundaram - Research Studies on Physicochemical Aspects of Pesticide Performance (conducted in 1990).

During 1990, the Pesticide Formulations Project at FPMI undertook two field studies, and two laboratory studies to examine (i) the influence of physicochemical properties of the end-use mixtures on droplet size spectra of the spray cloud, droplet spreading on foliage, and deposits on glass plates; and (ii) the rainfastness of foliar deposits of B.t. and glyphosate formulations.

Field Studies:

Effect of Droplet Size and Cumulative Rainfall on Rainfastness of Foray 48B deposits on balsam fir foliage under field conditions:

A small scale field study was conducted using the single tree treatment technique to determine the rain-fastness of foliar deposits of B.t. as determined by spruce budworm bioassay using 4th instar larvae. Foray 48B was diluted with water and sprayed over balsam fir seedlings (about 1 m high) at a dosage rate of 32 BIU in 4 L per ha, using a spinning disc atomizer, Micron Flak[R], calibrated to gerenate a narrow drop size range with an NMD of 80 um and a VMD of 86 um. Drops were counted on fully flushed needles and drops per sq. cm were evaluated.

Simulated rainfall of two different drop size spectra (almost monosized drops), with VMD values of 250 and 400 um, and two different cumulative rainfalls of 1 and 3 mm, were generated using Micron Herbi[R], and applied onto the seedlings at 24 h after B.t. application. Foliar branch tips containing fully flushed young buds were collected at different intervals of time up to 14 d after B.t. treatment, for bioassay using laboratory reared spruce budworm larvae. Mortality was assessed daily, and body weight depression once in two days, for a period of 14 days after treatment.

A comparative evaluation of the data on post-spray (within 15 min after application) and pre-rain samples (i.e., those collected at 24 h post-treatment) indicated that about 30% of B.t. activity was lost in 24 h after application. B.t. deposits were washed off under both intensities of rainfall, but wash-off was significantly higher at 3 mm than at 1 mm rain. Cumulative rainfall influenced B.t. wash-off from fir foliage much more than the droplet size of rain. Body weights were more depressed and mortality was higher in insects fed with buds collected before the rainfall, than with those collected post-rain. The data will be used to develop a model to understand the inter-relationships between size and impact velocity of rain drops, cumulative rainfall, and B.t. wash-off from balsam fir foliage.

Body weight depression and bioassay results on samples collected up to 14 d after treatment from seedlings that received no rain indicated that initial loss of B.t. activity was rapid within two days after treatment (a loss of about 50% of the deposited amount) but further loss was relatively slow. Measurable but very low B.t. activity still persisted for up to 9 to 10 d after treatment. This was detectable both by body weight depression and by low larval mortality. Further studies are on the way to understand the mechanism of loss of B.t. activity from treated foliage.

Collaborative Research Areas: The principal researcher will be willing to collaborate with USFS researchers in the following areas:

1) Factors contributing to the rainfastness of pesticides (e.g. droplet size and formulation properties)

2) Pesticide mechanisms.

2) Principal Researcher: Leo Cadogan - Efficacy of Dipel 352 (Dipel 16L) against spruce budworm.

A trial was conducted in NW Ontario to determine the efficacy of Dipel 352 (Dipel 16L) against fairly high (25 to 62 larvae/45 cm branch) populations of spruce budworm. The B.t. was sprayed undiluted at 30 BIU/ha (0.9 l/ha) and the budworm responses were examined on black spruce _Picea mariana_ and balsam fir _Abies balsamea_ species with widely different phenological developments.

One treatment matched the development of balsam fir (= peak budworm L_4) and the other block was sprayed 9 days later to match black spruce's development (= peak L_5). Results indicate that when the spray was timed to suit balsam fir development, budworm population reduction was less on both host species than when it was timed to suit black spruce.

In both blocks, defoliation was not different from that in the control. This suggests that these treatments were not effective against high budworm populations in protecting host tree foliage.

Areas of Collaborative Research: The principal researcher would like to collaborate with USFS researchers in the following areas:

1) Experimental design, methods and evaluation of aerial field trials.

2) Spraying and block marking techniques.

3) Responses of defoliations to insecticides.

3) Principal Researchers: Kees van Frankenhuyzen and Vince Nealis

a) Dose acquistion of B.t. by spruce budworm in relation to larval development, foliar deposits and persistence and weather conditions.

b) Foliar persistence of aerially applied B.t. on balsam fir in relation to weather conditions.

c) The influence of B.t. application timing on the survival of some spruce budworm parasitoids.

This research was conducted simultaneously with the efficacy trial. The results are currently being analyzed. Contact Kees van Frankenhuyzen or Vince Nealis for further information.

3) Principal Researcher: B.V. Helson - Insecticide Toxicology

a) New Insecticide Development

We have been assessing the potential of 4 new insecticides for the control of forest defoliators; alpha-terthienyl, RH5992, abamectin and its semi-synthetic derivative, MK-243 in the laboratory. Alpha-terthienyl, a natural phototoxic compound from members of the plant family, Asteraceae, has prevouslyy been tested on spruce budworm, jackpine budworm, eastern hemlock looper, forest tent caterpillar, white-marked tussock moth, and black army cutworm in collaboration with Dr. J.T. Arnason and A. Ceccarelli, U. of Ottawa and Dr. W.J. Kaupp, FP.I. In 1990 alpha-terthienyl was evaluated on gypsy moth larvae, but further tests are needed to confirm its toxicity. To date, all tests have been topical applications followed by exposure to near-UV light. We plan to asses its toxicity to SBL and EHL by ingestion and crawling contact exposure.

RH5992 is a novel insect growth regulating compound discovered by Rohm and Haas and under development bythemm. Dr. A. Retnakaran, FPMI, and I have been evaluating this compound against several forest lepidopteran defoliators. I have examined its toxicity to spruce budworm, eastern hemlock looper and gypsy moth larvae by direct contact and on sprayed foliage as well as its effects on feeding rates. In addition, the effects of exposure period on toxicity and the residual toxicity of RH5992 are being investigated.

Abamectin has been isolated from a soil microorganism, Streptomyces avermitilis by the Merck Sharp and Dohme Research Laboratories and is now registered as an miticide in the USA. MK-243, a semi-synthetic derivative of abamectin, has recently been developed and is reported to have very high activity to Lepidoptera. We have just begun testing MK-243 on SBL and EHL in comparison with abamectin. It appears to be very potent to these pests. We pln to expand our screening program against several other forest pests including gypsy moth.

b) White Pine Weevil

For several years we have been assessing the potential of pyrethroids, particularly permethrin, for the control of WPW adults in the laboratory with encouraging results. In 1990, P. deGroot, FPMI, and I collaborated in conducting a field trial to assess the effectiveness of permethrin in protecting leaders of jackpine from weevil attack. Leaders were sprayed by hand with dosages of 70 and 140 g AI/ha in early spring. Methoxychlor was sprayed at 1 kg/ha as a standard for comparison.

c) Pine False Webworm

In 1990, D.B. Lyons, Forestry Canada, Ontario Region, and I collaborated in laboratory and field trials to develop an insecticide control strategy for the pine false webworm on red pine. Laboratory bioassays with 10 common, rgistered insecticides were carried out with newly hatched larvae on sprayed red pine branches. Field trials were then conducted with Ambush 500EC (permethrin) at 35, 70 and 2 x 35 gAI/ha, and Sevin XLR Plus (carbaryl) at 12, 250, 500 and 2 x 125 gAI/ha applied by mistblower in a red pine plantation.

d) Seedling Debarking Weevil

For the past three years we have been conducting insecticide bioassays with *Hylobius congener* adults in cooperation with Bruce Pendrel, Foresty Canada, Maritimes Region. The residual effectiveness of permethrin, chlorpyrifos and fenitrothion for protecting conifer seedlings for up to 2 years is being evaluated by spraying or dipping potted white spruce and red pine seedlings with selected concentrations of these insecticides, placing the seedlings outdoors and exposing weevils to them at yearly intervals.

e) Other Pests

We recently completed field trials to determine the efficacy and optimum timing of permethrin for the control of spruce budmoth, *Zeiraphera canadensis* larvae in cooperation with M. Auger, Quebec Ministry of Energy and Resources. We are currently screening insecticides against *Conophthorus* cone beetles in collaboration with P. deGroot. We also conducted preliminary insecticide bioassays on black headed budworm, *Acleris variana* this year.

Collaborative Research Areas: The principal researcher is willing to collaborate in laboratory and field studies relating to these or other promising new products and to the development of insecticide control stratagis for the above pests and others of potential importance in Canada if resources and time permit.

4) Principal Researcher: John C. Cunningham - Virus Application Project

a) Gypsy Moth

Most of the activity of the virus application project has been focussed on gypsy moth for the last 3 years. A registration petition for Disparvirus, the name given to our Canadian product, was submitted in April 1990 and is currently being evaluated. Much of the data in this package were obtained from the Gypchek registration petition.

In 1988, a double application of Disparvirus at 1.25 x 10^{12} PIB/ha (total 10^{12} PIB/ha) in an emitted volume of 10.0 L/ha using an aqueous tank mix gave excellent results when applied on first instar larvae. However, this dosage and emitted volume are both considered to be too high for operational use. In 1989, a double application of 5 x 10^{9} PIB/ha (total 10^{12} PIB/ha) was tested at 10.0 L/ha and 5.0 L/ha on first instar larvae. The aqueous tank mix contained 25% molasses, 10% Orzan LS and 2% Rhoplex B60A sticker. The lower dosage was also deemed to be satisfactory. Hence the recommendation for Disparvirus application was changed to a double application of 5 x 10^{11} PIB/ha in 5.0 L/ha.

In 1990, a further reduction in emitted volume to 2.5 L/ha was tested and compared to 5.0 L/ha using the aqueous tank mix. Results with 2.5 L/ha were not as good as 5.0 L/ha, so a further reduction in emitted volume is not recommended when using this aqueous tank mix. A trial was also conducted during the 1990 season, with Gypchek, which was supplied by USDA Forest Service colleagues. The dosage was a double application of 5 x 10^{11} PIB/ha (total 10^{12} PIB/ha) in 5.0 L/ha using an emulsifiable oil tank mix. Larvae were mainly in the first instar at the time of application. The tank mix contained 25% Dipel 176 blank carrier vehicle and 75% water. Excellent results were obtained and it is suggested that this tank mix and dosage be tested at an emitted volume of 2.5 L/ha.

A commercial source of gypsy moth viral insecticide is vital if it is going to be used operationally in Ontario. FPMI is negotiating with Espro and several funding agencies with a view to establishing a pilot plant in the Institute and eventually a production facility in Sault Ste. Marie.

b) Douglas-fir Tussock Moth

A Canadian viral insecticide for Douglas-fir tussock moth called Virtuss and the USDA Forest Service product called TM BioControl-1 were both registered in Canada in 1983. In 1983, the last outbreak of Douglas-fir tussock moth in B.C. terminated and neither of these products has been used operationally.B.C. Forest Service holds supplies of sufficient TM BioControl-1 to trat 8,000 ha and sufficient Virtuss to treat 1,400 ha. An outbreak of Douglas-fir tussock moth is predicted for 1991; these products will be applied operationally if the outbreak occurs.

The recommended dosage of virus for Douglas-fir tussock moth is 2.5×10^{11} PIB/ha in either an aqueous, molasses and Orzan tank mix or an emulsifiable oil tank mix applied at 9.4 L/ha. Non-replicated trials in 1982 indicated that a lower dosage. 8.3×10^{10} PIB/ha, gave acceptable results. The virus is known to spread and "seeding" it into the insect population using widely spaced swaths has been suggested.

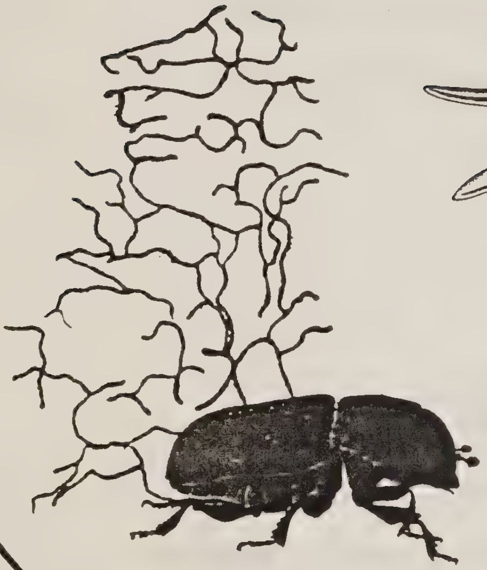
c) Redheaded Pine Sawfly

Lecontvirus, for control of redheaded pine sawfly, was registered in Canada in 1983. It is the only viral insecticide which is routinely used on an operational basis in Canada. Our principal client has been the Ontario Ministry of Natural Resources, although Quebec Department of Energy and Resources used Lecontvirus experimentally in the 1970's and have requested material for 1991. Dosage is 5×10^{9} PIB/ha applied in 10.0 L/ha from the air and 20.0 L/ha with ground spray equipment. The virus is produced inexpensively by treating heavily infested plantations and harvesting diseased and dead colonies of larvae. Between 1976 and 1990, 590 red pine and jack pine plantations with a total area of 4,855 ha have been treated.

d) European Pine Sawfly

A registration petition for Sertifervirus to control European pine sawfly was submitted in 1985 and is still being evaluated. The petition was based on the USDA Forest Service Neochek-S petition. The American product was registered by EPA in 1983 for use in the USA. European pine sawfly virus was extensively used on infested Scot's pine Christmas tree plantations in Ontario in the 1950's and 1960's with no thought given to registration and no records kept of areas treated. This insect is currently only a minor pest. Between 1976 and 1990 only 4 plantations, with a total area of 160 ha, have been treated. However, if a registration is obtained for Sertifervirus, greater use will be made of this product. Recommended dosage of 5×10^{9} PIB/ha is the same as that for Lecontvirus. Sertifervirus is also produced by spraying heavily infested plantations and harvesting diseased and dead colonies of larvae.

IDAHO FOREST INSECT and DISEASE REPORT



GYPSY MOTH ERADICATION PROGRAM

in

IDAHO

1989

Sandpoint and Coeur d'Alene

Bonner and Kootenai Counties

by

Robert (Bob) Tisdale, Gypsy Moth Program Coordinator

R. Ladd Livingston, Supervisor-Insect & Disease Section

STATE OF IDAHO

DEPARTMENT OF LANDS

COEUR D'ALENE

Report No. 90-4
October 1990

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ABSTRACT

The Idaho Department of Lands with cooperation from the USDA Forest Service, Region 1, and the USDA-Animal and Plant Health Inspection Service implemented plans to eradicate the gypsy moth, *Lymantria dispar* L. from two infestation sites in north Idaho. Approximately 110 acres in Coeur d'Alene and 270 acres in Sandpoint were treated with *Bacillus thuringiensis* (Bt), a biological insecticide. Each site received three aerial applications of Bt at 7- to 10-day intervals.

A mass trapping program was implemented as a follow-up to the insecticide treatment using a trap density of 9 per acre. Approximately 150 acres in Coeur d'Alene and 675 acres in Sandpoint were trapped. A total of 28 moths were caught in Coeur d'Alene and 23 in Sandpoint. This represents a reduction from last year's catches of 67 percent and 93 percent, respectively. Two small infestations were delineated in each city.

An intensive egg mass survey was conducted covering 4 acres in Coeur d'Alene and 6 acres in Sandpoint. Two egg masses were found in Coeur d'Alene at one site. In Sandpoint five egg masses were found, four of which were at one site.

INTRODUCTION

The gypsy moth was first detected in Idaho in 1986 when one male moth was caught in a pheromone-baited survey trap at Sandpoint. In 1987, 22 males were caught at Sandpoint, 11 at Coeur d'Alene, and one each at Lewiston and Cascade.

An egg mass survey was performed in the Spring of 1988 with 1,440 properties being searched in Coeur d'Alene and 1,170 in Sandpoint. Forty-four egg masses were found in Sandpoint and three in Coeur d'Alene. A total of 4 properties in Coeur d'Alene and 21 in Sandpoint were found to have evidence of various gypsy moth lifestages.

In an effort to reduce the population as much as possible, a ground spray program was initiated in May of 1988. Orthene, an organic phosphorus insecticide, was used on ornamental trees, and the bacterium Bacillus thuringiensis, a biological insecticide, was applied to fruit trees. A total of 23 trees in Coeur d'Alene and 68 trees in Sandpoint were treated. Each tree was sprayed three times.

Summer pheromone trap and fall egg mass surveys revealed that the gypsy moth was still present in both towns. In Coeur d'Alene 87 male moths were caught and 2 egg masses located. In Sandpoint 334 male moths were caught and 32 egg masses located. A direct comparison of pheromone trap catches between 1987 and 1988 cannot be made as a grid system of trap placement covering all of the infested area was used for the first time in 1988.

In a fall evaluation of the gypsy moth situation, it was the consensus of the Idaho Department of Lands, the USDA Forest Service, the USDA-Animal and Plant Health Inspection Service, and the Idaho Department of Agriculture that the gypsy moth was established in Sandpoint and Coeur d'Alene and that an eradication effort should be initiated.

An environment assessment (Rivas 1989) was prepared covering several options; public meetings were held; news releases and general information was provided to newspapers and radio and television stations of the area; and general information covering the gypsy moth and announcements for the public meetings were hand-delivered or sent to all residents within the proposed treatment areas.

After reviewing the situation and receiving public comment, the Idaho Board of Land Commissioners on May 1, 1989, authorized implementation of plans to eradicate the gypsy moth from Idaho.

OBJECTIVES

1. To eradicate the gypsy moth from Idaho using the following procedures:

   a. To implement three aerial applications of the biological insecticide <u>Bacillus thuringiensis</u> (Bt) to infestation sites in Coeur d'Alene and Sandpoint. Bt works best on first through third instar larvae. Three applications of Bt are necessary due to the prolonged hatching period of gypsy moth and the short active life of the pesticide.

   b. To implement a mass trapping program as a follow-up to the insecticide treatment. Mass trapping is employed to further reduce and to locate any residual population not affected by the insecticide.

2. To conduct an intensive egg mass survey in areas where multiple moth catches occur. Results of egg mass surveys are used as gauges to measure the effectiveness of control programs and also as aids in planning future action.

PUBLIC INFORMATION

The information effort was to inform and educate the public about the pest, the need to control it, and the pesticide to be used. Special care was taken in selecting the pesticide due to concerns for the environmental and for human health when using an insecticide in an urban area. A total of four public meetings were held in Coeur-d'Alene and Sandpoint. Overall consensus was favorable for the spray project.

Numerous articles appeared in local newspapers throughout the time of the entire program. The content of the articles ranged from general information about the gypsy moth to announcing spray dates and times. Presentations were also given to the County Commissioners for both Kootenai and Bonner counties.

Fliers announcing the first aerial application of insecticide were distributed to residents within the project areas the evening prior to the first treatment (Appendix B and C). Local Boy Scout troops were contracted to distribute them.

A toxicology profile for the Bt pesticide used was sent with a cover letter explaining the project to all physicians in both Coeur d'Alene and Sandpoint so that they could be familiar with the product (Appendix D).

PROGRAM AREA

The aerially-applied pesticide treatment area for Coeur d'Alene was 110 acres (Figure 1) and for Sandpoint 270 acres (Figure 3). The treatment areas for both cities were determined from the previous year's moth catches and egg mass locations. A perimeter buffer area of one block was added to assure complete coverage.

The mass trapping area encompassed and extended beyond the spray area for both Coeur d'Alene (Figure 2) and Sandpoint (Figure 4). Kootenai, a suburb of Sandpoint and several other sites (Figures 2 & 4), were also mass trapped because of single moth catches in 1988. A total of 150 acres in Coeur d'Alene and 675 acres in Sandpoint were mass trapped.

Figure 1.

Coeur d'Alene spray area

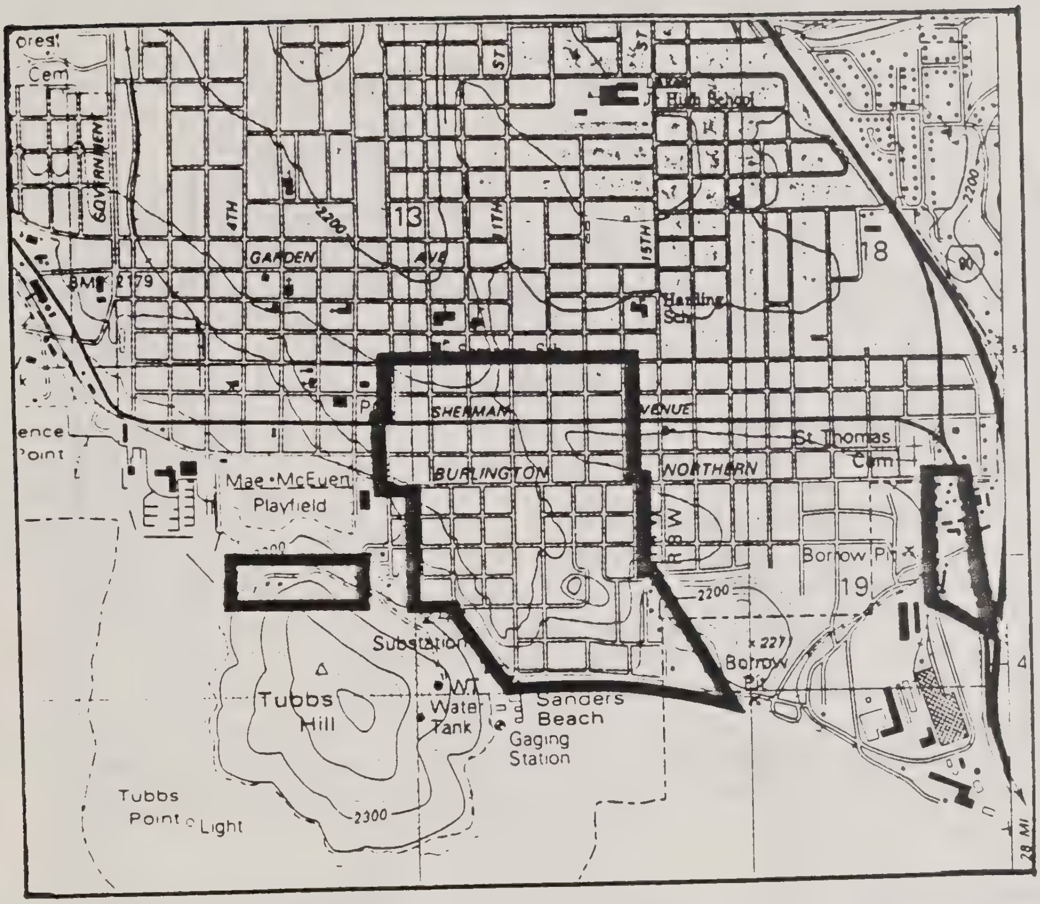


Figure 2.

Coeur d'Alene mass trapping areas

Figure 3.

Sandpoint spray area.

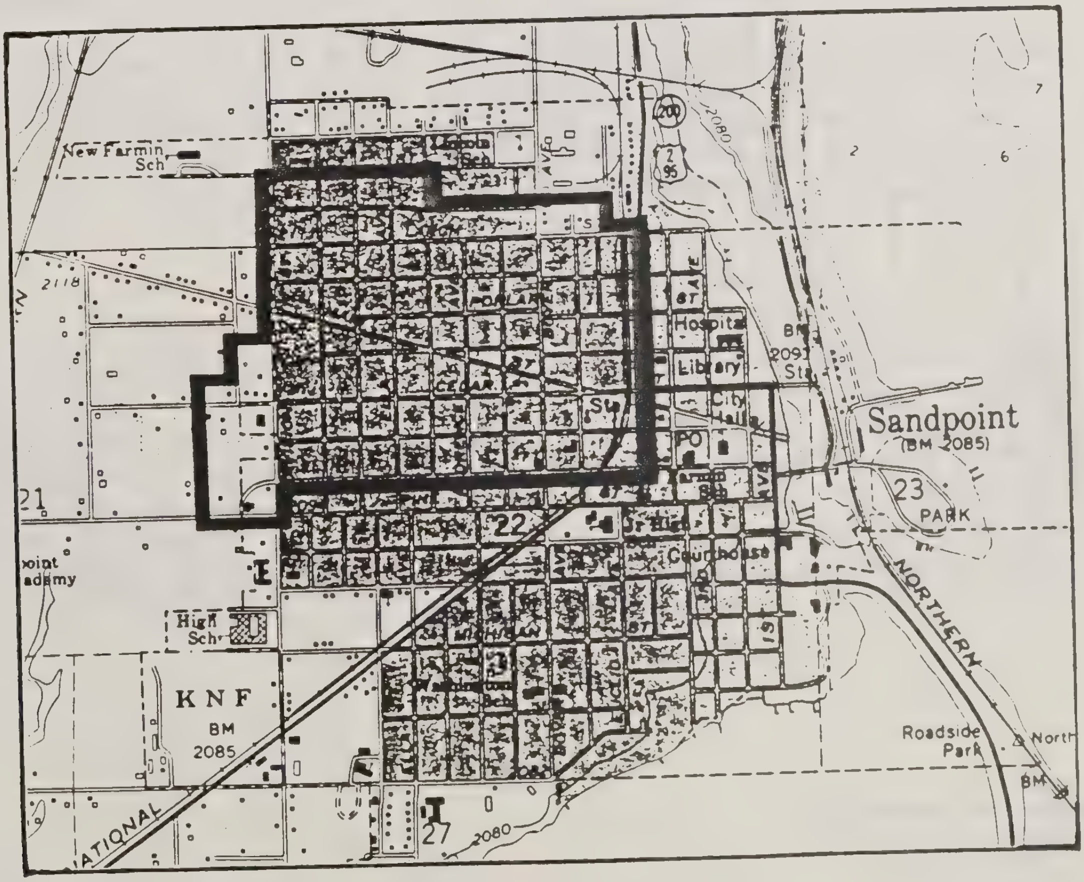
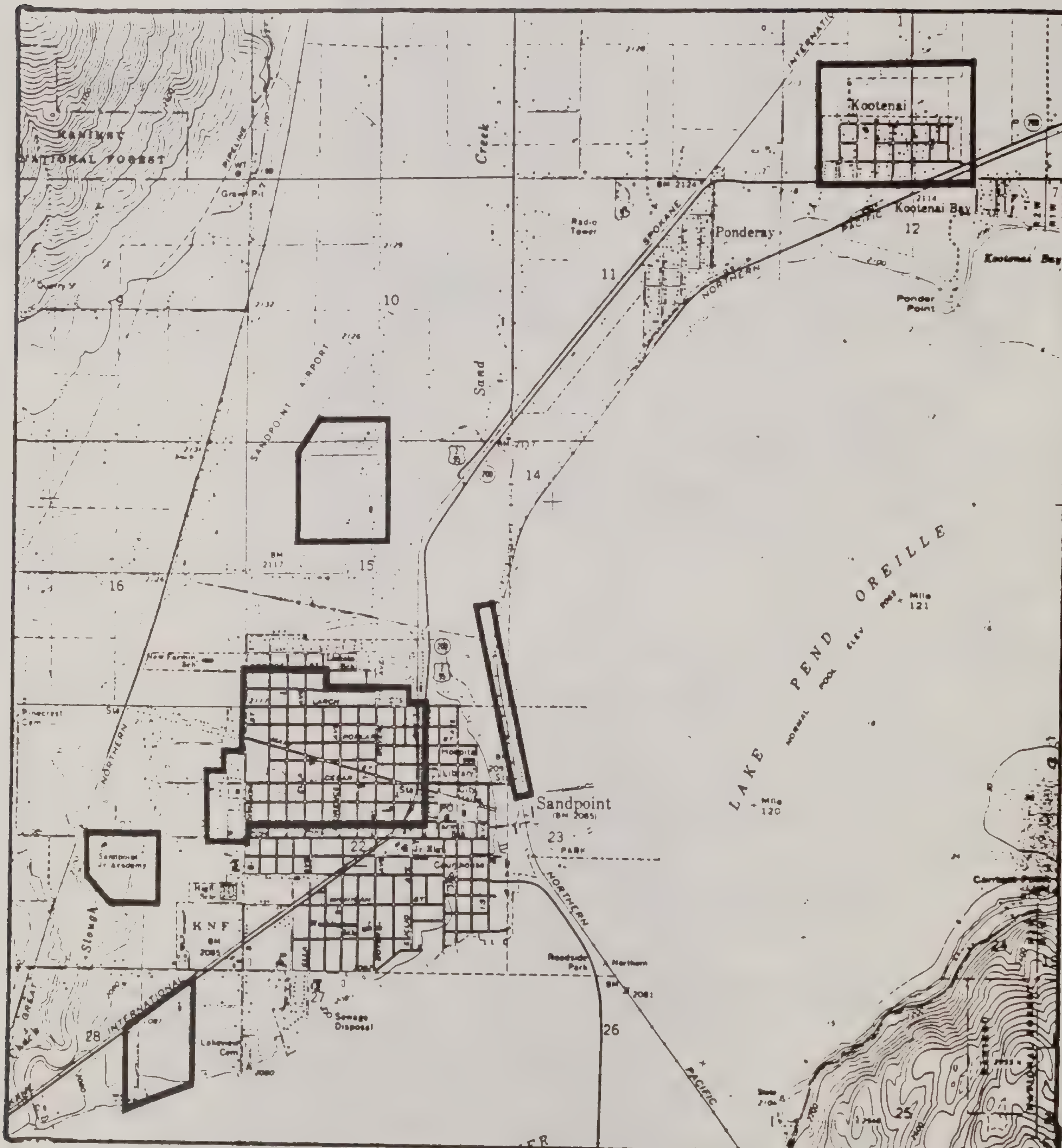


Figure 4. Sandpoint mass trapping areas.



INSECTICIDE

Description

Dipel 8L, a biological pesticide produced by Abbott Laboratories was the pesticide of choice due to its narrow range of target insects and lack of general impact on the environment. It is an emulsifiable suspension of the bacterium Bacillus thuringiensis (Bt) insecticide designed for forestry applications. The Bt used in Dipel is a naturally occurring bacterium that is common in the environment. It is selective in that it is a natural pathogen affecting only the insects in the Order Lepidoptera (moths and butterflies). It has no known adverse effects on other arthropods or life forms such as man, pets, fish, or birds. Dipel 8L contains 64 BIUs of Bt per gallon. This formulation disperses readily into water and forms a free-flowing spray suitable for low volume aerial application. Dipel 8L is not classified as a hazardous material. The mode of action of Bt is as a stomach poison. It must be ingested by the larvae to be effective. Proteinaceous crystals formed during sporulation of the bacterium disrupt the stomach lining of larvae and causes them to cease feeding.

Mixing and Storage

All mixing took place at the MICA Fire Protection District office in Coeur d'Alene and at the Idaho Department of Lands compound in Sandpoint. Both locations had asphalt pavement which was a requirement of the Idaho Department of Environment for mixing sites. A gel-type absorbent was kept at the site in the event of a major spill.

The insecticide was mixed in the ratio of one gallon Dipel to two gallons water. Application rate was three quarts (96 oz.) mixture per acre which gave a final delivery of 16 BIUs Bt per acre. Plyac, a latex-based sticker/surfactant was added at the rate of 2 percent by volume of water. The amounts of each component for both spray areas are shown in Table 1. Mixing was done the evening before each spray. There was no concern about the possibility of the Dipel coming out of suspension because mixtures of Dipel will remain stable for periods of up to 144 hours under normal field conditions.

Table I. Amounts of each ingredient for both spray areas (gallons).

	Sandpoint: 270 acres	Coeur d'Alene: 110 acres
Water @ 2 qts/a	135	55
Plyac @2% by volume	2.7	1.1
Dipel 8L @ 1 qt/a	67.5	27.5
Total	205.5	83.6

The bulk Dipel was stored at the MICA Fire Protection District office in Coeur d'Alene. The insecticide was delivered in seven 55 gallon drums and placed under an outdoor shed. Several sheets of plywood were placed around the drums to protect them from direct sunlight. There was no concern about the Dipel freezing because temperatures were well above this at that time of year.

MONITORING EGG MASSES

In order to apply the insecticide at the stage when the larvae were most vulnerable, egg masses were monitored in the field to determine when egg hatch and larvae dispersal and feeding began. Our plan was to begin the treatment soon after the eggs were hatched and larvae dispersed. Twenty-four egg masses were monitored in Sandpoint. The egg masses found in Coeur d' Alene in 1988 had been removed; therefore, no observations were made there. Observations began April 24 and continued until treatment began. The egg masses were collected and destroyed when hatching began.

A gypsy moth phenology model, GMPHEN[1] was also used to predict timing of egg hatch. GMPHEN is a computer model that uses daily temperatures and published data to predict the timing of gypsy moth development. GMPHEN had been used in 1988 and was accurate to within one day in predicting commencement of egg hatch.

Six egg masses were collected and brought to the Insect and Disease Laboratory in Coeur d'Alene. Larvae from three of the egg masses were used for a spray bioassay. They were reared on foliage from

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[1]GMPHEN: A gypsy moth phenology model; by Katharine A. Sheehan. USDA Forest Service, Portland, OR. Manuscript in review.

the two spray zones, and observations and mortality rates were recorded. The other three egg masses were used to determine percent of egg hatch.

SPRAY EQUIPMENT

The spray aircraft was a Hiller-Soloy 12E single-rotor, turbine-engine helicopter. The spray tank was fiberglass, with 140-gallon capacity, and externally mounted. The spray boom was 33 feet long and had three Beacomist Model 360A electronic rotary atomizer nozzles mounted on each side. The three nozzles on each side of the boom were spaced 21 inches apart with the inside nozzle 4.5 feet from the center of the aircraft. The contractor also furnished a 200-gallon fiberglass mix tank mounted on a one-ton flatbed truck. The mix tank was fitted with a recirculation pump which provided adequate agitation for mixing.

In order to gain authorization for low-level spray flights over the cities all aspects of FAA Agricultural Aircraft Operations Regulations 137.51 and 137.53 had to be complied with. Signs were posted on all major streets at the entrance to the spray areas on the day of each operation. Written approval was obtained from the mayors and city councils of Coeur d'Alene and Sandpoint. Notice of operation was given 48 hours in advance by radio, newspaper, and fliers. Flight plans were prepared and flight hazards and emergency landing sites were identified for each city. Pilot experience and aircraft maintinance requirements were also met.

CALIBRATION AND CHARACTERIZATION

Calibration was performed at the MICA office heliport in Coeur d'Alene. Water was used since its specific gravity was essentially the same as that of the final mixture (.97). System malfunctions and leaks were detected and corrected at this time.

The six Beacomist nozzles produced a 50-gallon delivery rate in 6.6 minutes at a boom pressure of 27 psi. This coincided with the predetermined figure of 10 acres per minute at 50 mph with an effective swath width of 100 feet. This gave the desired delivery rate of 96 ounces per acre.

Characterization was performed on the median strip at the Coeur d'Alene airport. Five cardlines, each with 20 cards at 10-foot intervals, were used. After the five trials, it was determined that drop density and volume median diameter (VMD) were within predetermined specifications of not less than 20 drops/cm^2 and 100-150 VMD, respectively. The predetermined altitude of 50 feet was increased to 60 feet in order to obtain a swath width of 100 feet.

SPRAY DEPOSIT ASSESSMENT

Spray deposit was assessed using Spraying Systems Company Teejet[R] water-sensitive cards. Five cardlines, for each spray, were placed within the treatment areas in Coeur d'Alene and Sandpoint. Each cardline consisted of 10 cards spaced 20 feet apart. The cards, inserted in plastic holders, were placed in the middle of streets or, if no canopy was present, on sidewalks. The cards were picked up immediately after the spray had settled in order to prevent damage to them from automobiles.

The cards were later analyzed for drop density and VMD. Drop density was determined using a plastic template. VMD was determined using the D-max method (Dumbauld and Rafferty 1977).

Spray behavior and deposit was modeled using the FSCBG model developed by the USDA Forest Service (Bjorklund and others 1988). Model runs were completed for both Coeur d'Alene and Sandpoint.

FLIGHT PATH FOLLOWING

A Pathlink™ Recorder Model PR2000 supplied by Pathcor Div. of Technology Projects Ltd., Tempe, Arizona, was mounted on board the spray aircraft. The Pathlink system provides a method for determining and documenting location based on latitude and longitude, and event status of any vehicle operated within a geographical area covered by an adequate LORAN-C signal. We attempted to record flight path and spray boom on\off information.

METEOROLOGICAL CONDITIONS

Spot weather forecasts were provided by the National Weather Service in Missoula, Montana. Weather data was collected at the spray site the morning before each treatment and submitted to the weather service via a Data General communications computer located at the MICA Fire Protection District office in Coeur d'Alene. The forecast was received by late afternoon the same day. Weather information was also obtained from the flight weather service at Spokane airport. Decisions on whether or not to commence treatment were based on information from these two sources.

There were eight criteria for terminating the spray operation (Rivas 1989). However because of the time of year and time of day when the operation was scheduled, we were only concerned with two of them, wind speed of greater than 8 mph and threat rain within six hours of application.

MARKING SPRAY BOUNDARIES AND SWATHS

Forty-inch yellow helium balloons were used to mark the spray area boundaries and swaths. Each balloon was attached to a 100-foot length of braided fishing line. One balloon was placed at each corner of the treatment areas to mark the boundaries. To mark the swaths, balloons were placed at 400-foot intervals on one side of the spray zone. The pilot was able to estimate each 100-foot swath width between the 400-foot markers.

Caution signs were placed at major intersections leading into the treatment areas. The signs were 18-inch by 28-inch orange construction paper with black lettering. These were attached to fold-out type highway markers provided by the Idaho Department of Transportation.

MASS TRAPPING

Mass trapping has been used in conjunction with aerial insecticide applications to eradicate isolated populations of gypsy moth. In addition to serving as a control method, mass trapping is also a very effective means of pinpointing any residual population not affected by the insecticide application.

A trap density of 9 per acre was used for residential areas. Trap placement location was determined with the aid of aerial photographs. The acreage of each city block was calculated, and the appropriate number of traps assigned to them. Trap locations for each block were specified by making marks on the photograph with a felt pen. The marks, representing trap locations, were spaced as evenly as possible. This procedure greatly aided trap personnel in placing traps.

A trap density of 6 per acre was used in wooded areas. Locations to be trapped were indicated on maps, and personnel used 85-foot strings to set up a grid within these areas.

Information for each trap was recorded on individual data cards (Appendix E). Information recorded included city-site, trap number, address, location diagram, date placed, service record, and date removed. The location diagram was drawn so that someone other than the trapper could find the trap if need be.

In addition to placing traps, personnel were responsible for promoting good public relations. This included informing property owners about gypsy moth and the mass trapping program. Personnel were instructed to spend considerable time in this effort. Property owners were asked for permission before traps were placed.

If no one was at home, a letter (Appendix F) was left instructing the owner to call the Department of Lands if they did not want traps on their property.

It was predicted that some traps could not be placed due to property owners refusal to give permission. Trap personnel were instructed to assign a trap card and number for these locations. It was decided that, if a very large gap in trap placement was created because of refusals, personnel would return at a later date and try to obtain permission.

The trapping program began June 12 with a training session in Sandpoint. Trap placement began June 13 and ended July 17 when all traps were in place. All traps were checked twice weekly from July 22 until September 8. When a moth was caught, the trap was removed, replaced with a new one, and brought to the lab for positive identification of the moth.

EGG MASS SURVEY

An intensive egg mass survey was conducted following the mass trapping program. An intensive egg mass survey is used for small populations when a walk-through survey would result in no egg masses being detected. Selection of areas to be surveyed were based on having greater than four positive catches within one city block.

BUDGET

This project was funded by the Idaho Department of Lands with cooperative cost share suppression funds being provided by the USDA Forest Service, Region 1, and the USDA-Animal and Plant Health Inspection Service. Cost per acre for the spray project was $123.87/acre and $67.78/acre for mass trapping. Table II shows a budget summary.

RESULTS

Egg Mass Monitoring

Hatching of egg masses took place over a nine-day period (Table III). The first observed hatch was on April 28 when four egg masses began to hatch. The last egg mass began to hatch on May 5. The greatest number of egg masses that began to hatch on a single day was nine and occurred on May 3. GMPHEN predicted that egg hatching would commence on May 2.

Table II. Budget summary.

ITEM	COST
Spray:	
Aircraft	$27,690.00
Plyac	525.00
Personnel	10,842.47
Travel and Per Diem	1,333.41
Supplies	1,460.45
Vehicles	881.41
Miscellaneous	1,245.12
Public Meetings	915.43
Environmental Assessment	2,178.89
Sub-Total	47,072.18
Trapping:	
Personnel	51,154.27
Travel and Per Diem	2,286.41
Supplies	1,120.88
Sub-Total	54,561.56
Egg Mass Survey:	
Personnel	2,129.23
Total	103,762.97

Table III. Hatching dates of egg masses.

Date	4/28	5/1	5/2	5/3	5/4	5/5
Number hatching	4	3	3	9	1	1

All egg masses were removed and destroyed when the first hatching began except for two of them. These were left to determine how long the larvae remain on the egg mass before they disperse. Both

of these egg masses began to hatch on May 3. The larvae remained clustered on the egg mass until May 7, a period of four days. Of the 24 egg masses monitored, all but three had hatching take place.

Of the six egg masses brought to the laboratory, all had egg hatching occur. When hatching had apparently ceased, three of the egg masses were placed in the freezer overnight. This facilitated counting the larvae to determine the percent of egg hatch. Percent of egg hatch ranged from 92 percent to 96 percent (Table IV). The other three egg masses, the larvae of which were used in the spray bioassay, appeared to have hatching rates similar to those described above.

Table IV. Summary of percent egg hatch data.

Egg mass	Total eggs	Number hatched	Percent hatched
1	643	598	93
2	436	403	92
3	505	485	96

Spray Bioassay

Treated foliage from the second and third spray was used for the bioassay. Of the 52 larvae fed foliage from Sandpoint, there were no survivors. Of the 38 larvae fed foliage from Coeur d'Alene, there were four that survived to the adult stage. Two of these had developmental rates about three weeks longer than larvae reared on untreated foliage.

Spray Operation

Based on timing of egg hatch, the first spray for Coeur d'Alene was scheduled for May 10 and for Sandpoint May 11. Due to rain and high winds, the first spray was delayed for two days. The second spray for Coeur d'Alene and Sandpoint was completed on May 21 and May 22, respectively. The third spray for Coeur d'Alene was completed on May 30 and for Sandpoint on June 2.

Spray Deposit Assessment

Results are provided in Table V. Droplet density ranged from 3.9 to 29.1 and VMD from 109.7 to 132.6 for Coeur d'Alene. For Sandpoint, droplet density ranged from 19.8 to 52.3 and VMD from 104.8 to 116.9. The results for Coeur d' Alene are based on only four of the cardlines. The fifth cardline was located along the south border of the area next to the lake and, as predicted by the FSCBG spray behavior model (Bjorklund and others 1988), no spray was deposited there due to the prevailing south winds.

Table V. Summary of spray deposit data.

Spray	Drop density #/cm	VMD
Coeur d' Alene:		
1	10.85	109.67
2	3.94	132.58
3	29.10	124.46
Sandpoint:		
1	19.76	116.89
2	32.24	104.77
3	52.25	109.10

Flight Path Monitoring

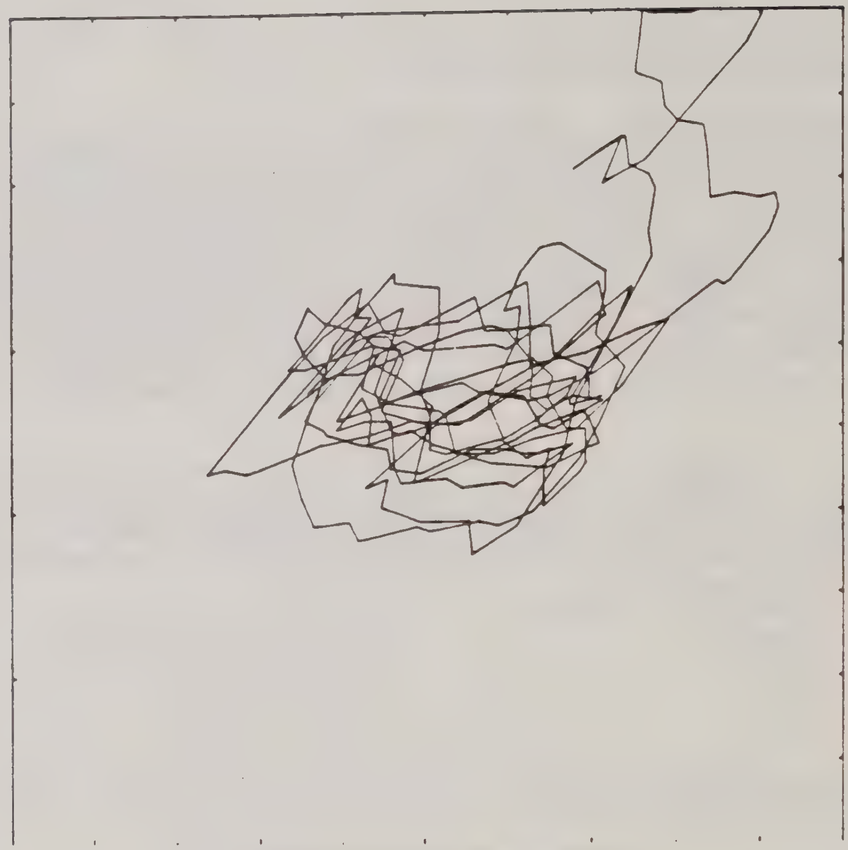
The flight path following system did not function as anticipated. Apparently the Hiller-Soloy 12E helicopter generated excessive static electricity that caused the figures produced by the system to show only jagged representations of the flight lines (Figure 5) that were not intelligible. Many efforts were tried using different Loran transmitters, improved grounding of the electronics units and different antennal positions, none of which improved the results.

Mass Trapping

A total of 1,343 traps were placed in Coeur d' Alene covering approximately 150 acres. There were no refusals from property owners to place the traps. A total of 5,907 traps were placed in Sandpoint covering approximately 655 acres. Due to property owner refusals, 117 traps were not placed. However, no large gaps were created in trap placement because of this.

Figure 5.

Unsuccessful plotting of spray block flight lines for Coeur d'Alene



A total of 28 male moths were caught within the mass trapping area in Coeur d'Alene. Two small pockets were delineated (Figure 6). One of the pockets had 18 catches and the other had four (Figure 7). The remaining six catches were scattered throughout the trapping area. Two of these catches were outside the spray area. Four other moths were caught in detection traps (Figure 6 and Appendix G).

In Sandpoint 23 male moths were caught within the mass trapping area. Two pockets were delineated (Figure 8). One of the pockets had 10 catches and the other had eight (Figure 9). The pocket with eight catches was located one block outside the spray area. The remaining five catches were isolated single catches. Four of these were within the spray area and the other was outside. Six other moths were caught in detection traps (Appendix G).

Egg Mass Survey

Based on positive pheromone trap catches, two locations in Coeur d' Alene and two in Sandpoint were surveyed. In Coeur d' Alene

two egg masses were found on a single property (Figure 7). In Sandpoint five egg masses were found (Figure 9). Four of these were found in one area; three on a single tree, while the fourth was detected on an adjacent property.

Figure 6. Mass trapping areas showing locations of moth catches and positive detection trap sites in Coeur d'Alene.

● = eradication moth catch sites, 9 traps per acre

■ = positive detection survey sites, 36 traps per square mile, all single moth catches

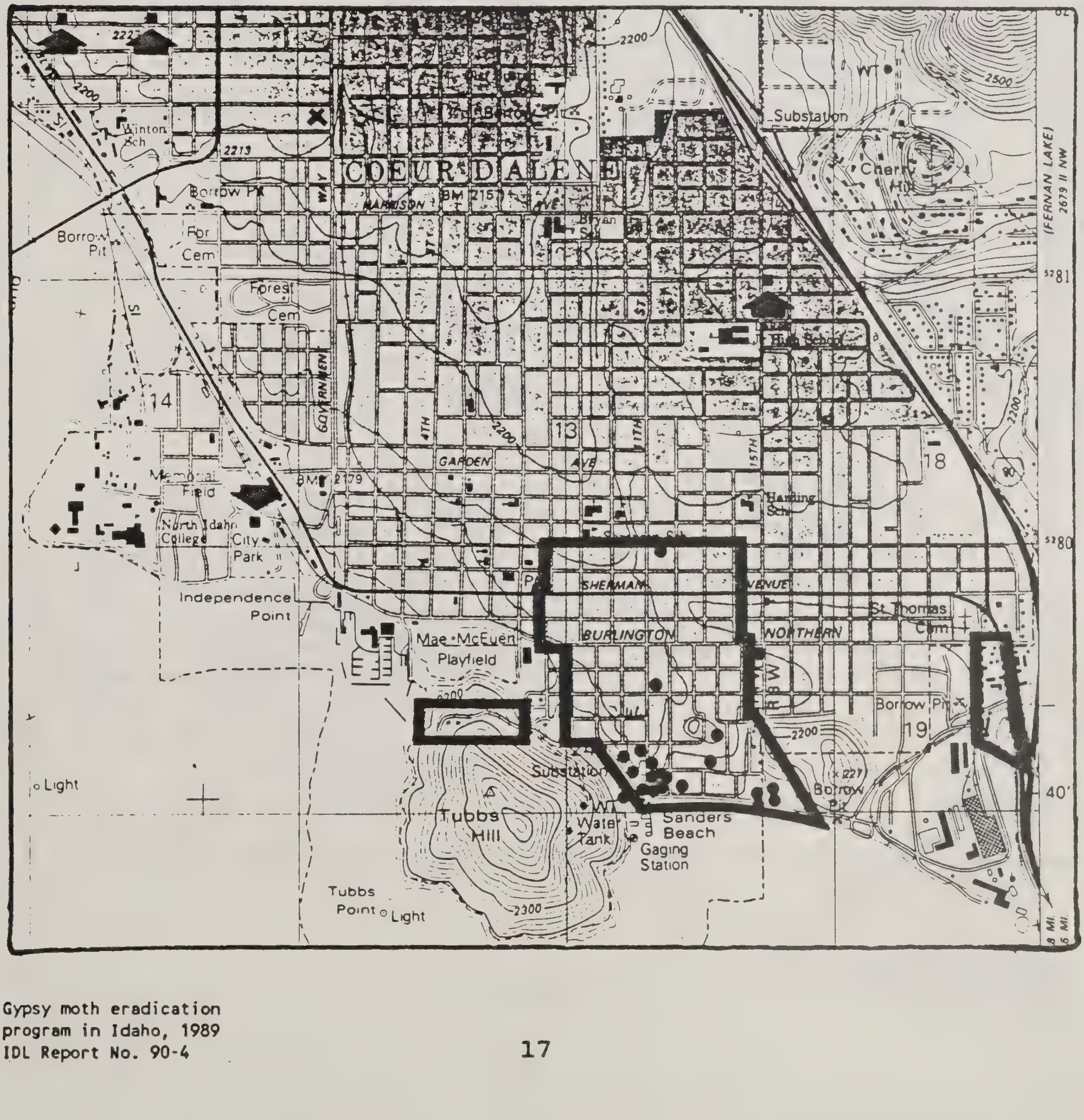


Figure 7. Detail of area of concentrated moth catches and egg masses found in Coeur d'Alene.

●ⁿ = site and number of moths caught

▲ⁿ = site and number of egg masses found

Figure 8. Mass trapping areas showing locations of moth catches and positive detection trap sites in Sandpoint.

● = eradication moth catch sites, 9 traps per acre

■ = detection survey moth catches, 36 traps per square mile. Extra traps were placed at time of 1st catch.

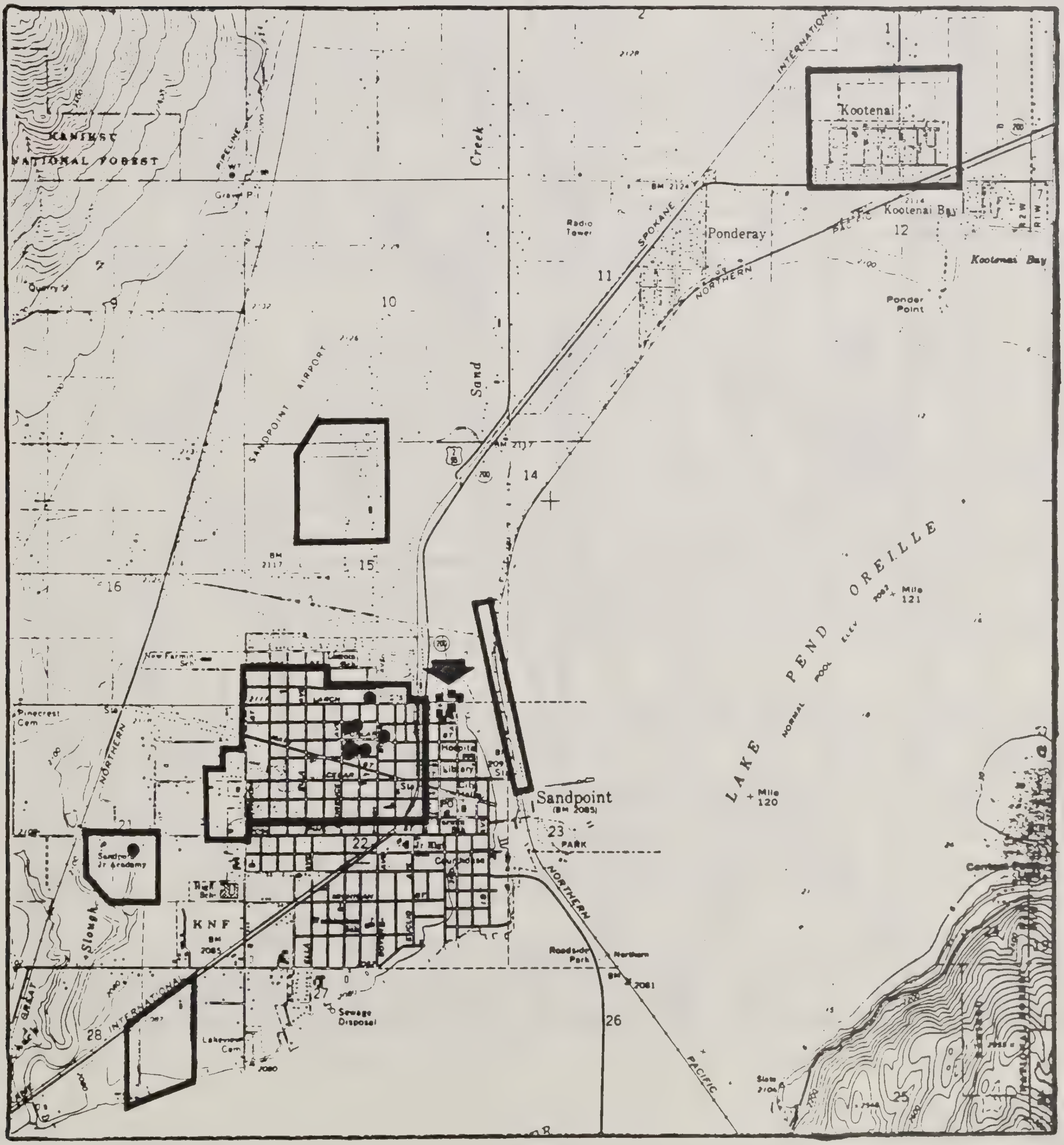


Figure 9. Detail of area of concentrated moth catches and egg masses found in Sandpoint.

$\bullet^{n}$ = site and number of moths caught

$\blacktriangle^{n}$ = site and number of egg masses found

DISCUSSION

In general the spray project and the mass trapping can be considered as successful. The pheromone trap counts in 1989 compared to 1988 dropped by 67 and 93 percent in Coeur d'Alene and Sandpoint, respectively. The egg masses were reduced in Sandpoint from 32 in 1988 to 5 in 1989. In Coeur d'Alene the numbers stayed the same with 2 in 1988 and 2 in 1989. However the infested area, as outlined by the survey traps, dropped from 110 acres to approximately 10 in Coeur d'Alene, and from 270 to 15 in Sandpoint.

The failure of the spray project to completely eradicate the gypsy moth population appears to be due to two factors. In Coeur d'Alene there was a continual south wind blowing from the lake that moved the spray inland before it was deposited. This had been predicted by the FSCBG model runs and the spray deposit cards showed this to be the case. The residual population, as determined by the pheromone traps and the location of the egg masses found, was confined to a narrow strip right along the lake shore. It appears that there was not adequate spray deposit to provide a lethal dose in that area.

In Sandpoint the residual population that was found within the boundaries of the spray block appeared to be associated entirely with one, very large, black walnut tree. Three of the four egg masses found at that site were on this tree and the fourth was only a very short distance away. We observed that all of the black walnut trees of the area were very slow in developing their foliage. The majority of the other host trees had nearly full foliage by the time of the first spray. When the foliage of the black walnuts did begin to develop, it appeared to grow so fast that there were new untreated leaves present within a very short time after each spray. This allowed a portion of the residual larval population to survive by feeding without contacting the pesticide.

The other Sandpoint population that was found outside of the spray area but within the mass-trapping zone may have resulted from an early instar female-caterpillar being blown by the wind the short distance outside of the original infestation area. It could have also resulted from movement of out door household articles. The low numbers of moths caught in the pheromone traps at that site would suggest that only one egg mass developed in the area.

The single moths that were caught some distance from the main population areas in both Coeur d'Alene and Sandpoint seem to have resulted from individuals that were either strong fliers or that got caught by the wind and were transported some distance from their point of origin. In all cases we have not caught any

additional moths when extra monitoring traps were placed around the sites where these single moths were caught.

While the mass trapping has obviously helped in the overall control effort, it apparently cannot be depended on to eradicate even low populations. This was demonstrated by our ability to find new egg masses within the trapping areas.

While we had hoped to eradicate the gypsy moth from Idaho with one year's efforts, it is apparent that it will take at least one more season.

REFERENCES

Bjorklund, J.R., C.R. Bowman and G.C. Dodd. 1988. User guide - Forest Service aerial spray computer model - FSCBG2. USDA Forest Service Forest Pest Management FPM 88-5

Dumbauld, R.K. and J.E. Rafferty. 1977. Field manual for characterizing spray from small aircraft. H.E. Cramer C., Inc. Salt Lake City, UT. Prepared for the USDA Forest Service, Equipment Development Center, Missoula, MT and the Methods Application Group, Davis, CA. 68p.

Rivas, A.M. 1989. Environmental assessment; gypsy moth eradication spray program. Bonner and Kootenai Counties, Idaho. Forest and Range Land Services, Ogden, UT. Prepared for the Idaho Department of Lands, Coeur d'Alene, Idaho. 36p.

1989 GYPSY MOTH CONTROL PROJECT PERSONNEL

Project Director - R. Ladd Livingston
Project Coordinator - Bob Tisdale

Spray Program:

Ground crew	-	David Beckman Faith Bergem Tina Green Mike Brown
Flight following	-	Sandra Gast
Heliport managers	-	Steve Douglas Thomas Johnson (T.J.)
Pilot	-	James R. Pope
Crew chief	-	James D. Pope
Mixer	-	Greg Garris

Mass Trapping Program:

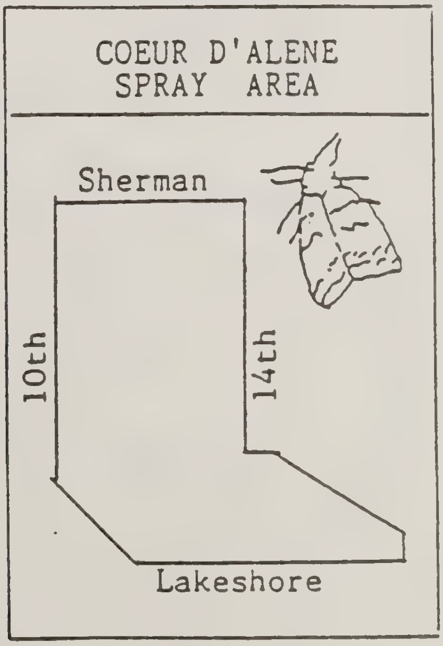
Sandpoint trap crew	-	Cheryl Aragon Mike Booth Mike D. Brown Mike L. Brown Sue Fogey John Krackenberg Alischia Matthews Jeannie Mikkelsen Jeff Ward
Coeur d'Alene trap crew	-	Faith Bergem Russ McCabe Janet Walker
Records clerk	-	Tina Green

FLIER DISTRIBUTED TO RESIDENTS WITHIN COEUR d'ALENE SPRAY AREA

GYPSY MOTH SPRAY

The Idaho Department of Lands anticipates to begin aerial spraying for the gypsy moth on May 11, 1989. The actual spray date will depend on local weather conditions. Please listen to radio station KVNI for any changes. The spraying will start at approximately 5:00 a.m. and will end before 7:00 a.m. Two more sprays will be done at 7-10 day intervals following the first spray. The exact dates of the next sprays will be announced in the newspaper, on Radio station KVNI, and on Television station KXLY.

If you have any questions concerning the spraying please call the Department of Lands at 664-2171.

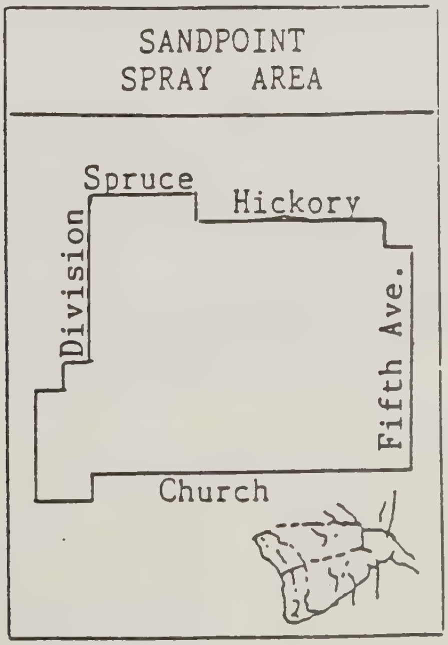


FLIER DISTRIBUTED TO RESIDENTS WITHIN SANDPOINT SPRAY AREA

GYPSY MOTH SPRAY

The Idaho Department of Lands anticipates to begin aerial spraying for the gypsy moth on May 12, 1989. The actual spray date will depend on local weather conditions. Please listen to radio station KSPT for any changes. The spraying will start at approximately 5:00 a.m. and will end before 7:00 a.m. Two more sprays will be done at 7-10 day intervals following the first spray. The exact dates of the next sprays will be announced in the newspaper, on Radio station KSPT, and on Television station KXLY.

If you have any questions concerning the spraying please call the Department of Lands at 664-2171 - Coeur d'Alene
263-5104 - Sandpoint



LETTER AND PESTICIDE TOXICOLOGY PROFILE SENT TO PHYSICIANS OF SANDPOINT AND COEUR D'ALENE

IDAHO DEPARTMENT OF LANDS
P.O. BOX 670, COEUR D'ALENE, IDAHO 83814

STANLEY F. HAMILTON
DIRECTOR

Date : April 28, 1989

Memorandum

To : Physicians of Sandpoint and Coeur d'Alene

From : R. Ladd Livingston, Ph. D.
Supervisor, Insect and Disease Section

Subject : Aerial Spray Project

During the first two weeks of May, 1989, the Idaho Department of Lands will begin aerially spraying portions of Sandpoint (see map) in an effort to eradicate the gypsy moth.

The biological pesticide to be used is Dipel (see attached toxicology profile). The active ingredient in Dipel is Bacillus thuringiensis (B.t.). It is a naturally occurring, soil inhabiting, ubiquitous bacterium. It is not toxic in any way to humans, animals, birds, or any insect other than caterpillars of moths and butterflies.

The spraying will begin at approximately 5:00 am and will end before 7:00 am. Two additional sprays will occur at 7-10 day intervals following the first spray. Exact dates for all sprays will be announced in the Sandpoint Daily Bee and on KSPT Radio.

We ask that you familiarize yourself with the aspects of this pesticide and help us in reassuring the general public of its safety. Your cooperation is greatly appreciated.

RLL/tg

LETTER AND PESTICIDE TOXICOLOGY PROFILE
SENT TO PHYSICIANS OF SANDPOINT AND COEUR D'ALENE

dipel®
Bacillus Thuringiensis Insecticide

TOXICOLOGY PROFILE

TOXICOLOGY

As evident from toxicology results, Dipel is one of the safest insecticides in use today. Its active ingredient is a bacterium, *Bacillus thuringiensis (B.t.),* which occurs naturally in the environment. *B.t.* has a highly specific mode of action. It effectively controls caterpillar larvae; however, the HD-1 strain of *B.t.* used in the production of Dipel has shown no toxicity to mammals, fish or other wildlife at recommended field rates. This is supported by Abbott's extensive toxicologic evaluation of Dipel and extensive testing by independent scientists. Further, in over 10 years of commercial use, no reports of adverse effects to the environment have been documented. Unlike most chemical pesticides, Dipel is ideally suited for use in integrated pest management programs since the active ingredient does not interrupt activities of beneficial insects.

ORAL TOXICITY

No toxicity in mice, rats or dogs has been demonstrated with single dosages up to 10,000 mg/kg of body weight.

Thirteen-week dietary administration of technical material to rats at dosages of 8,400 mg/kg/day produced no toxic effects.

Two-year chronic dietary administration of technical material to rats at 8,400 mg/kg/day produced no tumorigenic or oncogenic effects.

INHALATION TOXICITY

No toxic effects were observed in rats when Dipel 4L was instilled directly into the lungs at rates up to 5 mg/kg of body weight. This translates to a value 10,000 times greater than a bystander could expect during spray programs. Humans exposed daily to *B.t.* spores for over 10 years have shown no adverse effects.

DERMAL TOXICITY

Mild, transient dermal irritation was seen, but no systemic toxicity was noted in rabbits when Dipel 4L was applied to abraded skin at 1 mg/kg/day for 21 days. In other studies, a single epidermal application of Dipel 4L at 7.2 g/kg was not toxic to rabbits.

TOXICOLOGY TO BEES

No toxicity to honeybees has been demonstrated during extensive laboratory and field studies with Dipel products at labeled rates.

TOXICITY TO BENEFICIAL INSECTS

No toxic effects to beneficial or predacious arthropods have been observed at labeled rates of Dipel. These results are based on laboratory and field studies performed on over 200 species of beneficial insects/spiders in the orders: Hymenoptera, Diptera, Neuroptera, Orthoptera, Araneae, Coleoptera and Hemiptera. Due to its safety to beneficials and unique mode of action, Dipel is an ideal component of integrated pest management programs.

EYE IRRITATION

No corneal opacity was observed in rabbits treated with 0.1 ml of Dipel 4L. Only mild, transient irritation was noted in this study, and in other tests with wettable powder formulations.

SENSITIZATION

No evidence of sensitization was noted in guinea pigs given repeated subcutaneous injections of *B.t.* technical material.

I.V. INJECTION

A single I.V. dose of 10^8 *B.t.* spores was not toxic to young growing rats. There was no evidence of sporulation of *B.t.* within the visceral tissues over the course of a 112-day experiment.

TOXICITY TO FISH

No adverse effects were shown in rainbow trout and bluegills exposed to *B.t.* technical material for 96 hours at concentrations of 560 and 1,000 ppm.

A small marine fish, *Anguilla anguilla,* was not adversely affected by exposure to 1,000-2,000 times the level of *B.t.* expected during spray programs.

Field observations, one month after aerial application of Dipel, revealed no effects on populations of brook trout, common white suckers and smallmouth bass.

TOXICITY TO ZOOPLANKTON

Aerial spraying at labeled rate of Dipel 4L, had no effects on populations of Cladocera, Copepoda and Rotifera species.

TOXICITY TO BIRDS

LD_{50} — Bobwhite Quail — greater than 10 grams *B.t.*/kg body weight; autopsy of the birds revealed no pathology attributable to *B.t.* LD_{50} — Mallard — greater than 2000 grams *B.t.*/kg. Field observations of 74 bird species revealed no population fluctuations after aerial application of Dipel.

RESIDUES

Since Dipel products have not been shown to be toxic to nontarget organisms, spray drift and residues do not present a health hazard.

TOLERANCE

Dipel has been granted exemption from the requirement of tolerance on all registered crops in Canada and the United States. The wettable powder formulation may be applied to certain raw agricultural commodities after harvest.

VIRAL ENHANCEMENT

The susceptibility of cell cultures to viral infection was not enhanced after Dipel 4L exposure.

APPENDIX E

TRAP DATA CARD

TRAP NO. ______________ — ______________ (City/Site No.) (Trap No.)

COUNTY ______________________________

AREA ______________________________ (N, SW, SE)

SURVEYOR __________ (Initials)

CITY/SITE ______________________________

ADDRESS ____

DATE TRAPS SERVICED	TRAP CATCH (Put date trap set here)	INSPECTOR	PROPERTY DIAGRAM
			N W E S
			(If trap is relocated, indicate location of new trap site.)

IDAHO GYPSY MOTH SURVEY
TRAP CARD

LETTER ASKING PERMISSION TO PLACE TRAP

Date ______________________________

TO: Occupant(s) of ____

FROM: R. Ladd Livingston, Supervisor
Insect & Disease Section - 664-2171

SUBJECT: GYPSY MOTH TRAPPING PROGRAM

Each summer the Idaho Department of Lands conducts a trapping program to search for new introductions into our state of an insect called the "gypsy moth." This is accomplished by placing a small, orange or green gypsy moth trap in trees or on fence posts at strategic sites. The trap contains a lure which attracts male gypsy moths to it. The moths are then caught in the trap. There are no harmful chemicals in the trap.

Our survey technician (trapper) for your area has attempted to find someone home at your residence to request your permission to place a trap on your property. It is important that all traps be "in place" before the end of July. Therefore, the survey technician, in an effort to get the traps placed in time, has put one or more traps on you property at the following site(s):

____

____

If you would prefer not to have a trap on your property, please contact,

____
(Name) (Phone)

and the trap will be removed.

A survey technician will check your trap(s) twice during the summer, and remove the traps on the third visit at the end of September or early in October.

Attached is some literature about the gypsy moth and the trap.

Thank you very kindly for your assistance.

RLL/tg

APPENDIX G

LISTING OF MOTH CATCHES and EGG MASSES FOUND, BY ADDRESS

SANDPOINT, BONNER CO.

SURVEY TYPE*	TRAP NUMBER	ADD\DESC.	TRAP PERIOD #1 DATE	TRAP PERIOD #1 NO.MTHS	TRAP PERIOD #2 DATE	TRAP PERIOD #2 NO.MTHS	TRAP PERIOD #3 DATE	TRAP PERIOD #3 NO.MTHS	TOTAL MOTHS	EGG MASSES
d	20	PINECREST LOOP	9/25/89	1					1	
d	22	UPLAND DR	9/25/89	1					1	
d	23	UPLAND DR	9/25/89	1					1	
d	25	UPLAND DR	8/21/89	1					1	
d	48	MT VIEW RD	9/25/89	1					1	
d	58	WOODLAND DR	9/25/89	1					1	
**		321 LARCH							0	1
e	1608	805 BOYER	8/18/89	1					1	
e	2179	404 LARCH	8/16/89	1					1	
e	2187	302 LARCH	8/18/89	1					1	
e	2188	302 LARCH	8/16/89	1					1	
e	2204	712 FOURTH	8/16/89	1					1	
e	2207	716 FOURTH	8/16/89	1	8/21/89	1			2	
e	2212	719 THIRD	8/16/89	1					1	
e	2214	719 THIRD	8/16/89	1					1	
e	2308	602 BOYER	9/29/89	1					1	
e	2745	812 ALDER	8/08/89	1	8/15/89	3			4	3
e	2746	814 ALDER	8/08/89	1					1	
e	2747	808 ALDER	8/07/89	1	8/15/89	1	8/21/89	1	3	
e	2748	804 ALDER	8/22/89	1					1	1
e	2751	813 POPLAR	8/08/89	1					1	
e	2753	813 POPLAR	8/10/89	1					1	
e	2774	504 FOREST	8/07/89	1					1	
e	5269	2016 BROWNING	10/03/89	1					1	
		TOTALS: No traps: 23	No.Moths:	23		5		1	29	5

* "e" = eradication trap; "d" = detection trap
** egg mass only

LISTING OF MOTH CATCHES and EGG MASS FOUND, BY ADDRESS

COEUR D'ALENE, KOOTENAI CO.

SURVEY TYPE*	TRAP NUMBER	ADD\DESC.	TRAP PERIOD #1 DATE	TRAP PERIOD #1 NO.MTHS	TRAP PERIOD #2 DATE	TRAP PERIOD #2 NO.MTHS	TRAP PERIOD #3 DATE	TRAP PERIOD #3 NO.MTHS	TOTAL MOTHS	EGG MASSES
d	17	CITY PARK-PUBLIC RESTROOM	9/25/89	1					1	
d	71	1038 15TH	8/11/89	1					1	
d	134	MEDINA AVE	9/25/89	1					1	
d	135	1001 EMMA	9/25/89	1					1	
e	3	1109 CDA	8/22/89	1					1	
e	212	301 S. 15TH	8/23/89	1					1	
e	441	1307 ASH	8/23/89	1					1	
e	455	609 DOLLAR	8/15/89	1					1	
e	502	1415 E. LAKESHORE	8/15/89	1					1	
e	544	1215 E. LAKESHORE	8/11/89	1					1	
e	562	S. SIDE OF E. LAKESHORE DR.	9/18/89	1					1	
e	569	1501 E. LAKESHORE DR.	8/15/89	1					1	
e	576	1501 E. LAKESHORE DR.	8/29/89	1					1	
e	929	420 S. 11TH	8/10/89	1					1	
e	1257	815 S. 11TH	8/11/89	1					1	
e	1262	801 S. 11TH	8/17/89	1					1	
e	1266	777 S. 11TH	8/18/89	1					1	
e	1269	771 S. 11TH	8/15/89	1					1	
e	1277	720 S. 11TH	8/15/89	1					1	
e	1292	ASH ALLEY BET 11TH & 12TH	8/11/89	1					1	
e	1294	806 S. 11TH	8/07/89	1					1	
e	1296	1101 E. LAKESHORE	8/10/89	1	8/14/89	1	8/18/89	1	3	2
e	1297	1101 E. LAKESHORE	8/07/89	1	8/08/89	1	8/14/89	1	3	
e	1299	1103 E. LAKESHORE	8/14/89	1					1	
e	1300	1103 E. LAKESHORE	8/30/89	1					1	
e	1304	811 S. 12TH	8/11/89	1	8/14/89	1			2	
e	1320	1010 S. 10TH	8/22/89	1					1	
		TOTALS: No traps: 27	No.Moths:	27		3		2	32	2

* "e" = eradication trap; "d" = detection trap

AERIAL APPLICATION OF NUCLEAR POLYHEDROSIS VIRUS AGAINST DOUGLAS-FIR TUSSOCK MOTH, *ORGYIA PSEUDOTSUGATA* (McDUNNOUGH) (LEPIDOPTERA: LYMANTRIIDAE): I. IMPACT IN THE YEAR OF APPLICATION

I.S. OTVOS

Canadian Forestry Service, Pacific Forestry Centre, Victoria, British Columbia, Canada V8Z 1M5

J.C. CUNNINGHAM

Canadian Forestry Service, Forest Pest Management Institute, Sault Ste. Marie, Ontario, Canada P6A 5M7

and L.M. FRISKIE[1]

British Columbia Ministry of Forests, Kamloops, British Columbia, Canada V2C 2T7

Abstract

Can. Ent. 119: 697–706 (1987)

Four 10-ha plots located in Kamloops Forest District, British Columbia, containing Douglas-fir trees infested with Douglas-fir tussock moth were aerially sprayed with nuclear polyhedrosis virus (Virtuss) in 1982 when most larvae were in the first instar. A dosage of 2.5×10^{11} polyhedral inclusion bodies (PIB) per hectare was applied in an emulsifiable oil tank mix to one plot and the same dosage in an aqueous tank mix containing molasses was applied to a second plot. The remaining two plots were treated with dosages of 8.3×10^{10} and 1.6×10^{10} PIB per hectare, respectively, in the oil mix. The treatments were applied with a fixed-wing aircraft fitted with boom and nozzle equipment and calibrated to deliver 9.4 L/ha. A further four plots were selected as checks.

Population reduction at 6 weeks post-spray (calculated using a modified Abbott's formula) was 65% in the plot receiving the lowest dosage and from 87 to 95% in the remaining three plots. Incidence of virus infection, determined microscopically, peaked at 5–6 weeks post-spray with 85–100% of the larvae scored as positive. Levels of naturally occurring virus remained low in the check plots. Adult emergence from the pupae collected in the treated plots ranged from 4 to 19% and from 28 to 43% in the check plots. Reduction in egg-mass density attributed to the treatments was 97% in one plot, 99% in two others, and not determined for the fourth.

A virus dosage of 8.3×10^{10} PIB per hectare, which is one-third of the previously recommended dosage, is adequate, and either tank mix is acceptable.

Résumé

En 1982, quatre placettes de 10 ha situées dans le district forestier de Kamloops, en Colombie-Britannique, qui renfermaient des douglas taxifoliés infestés par la chenille à houppes du douglas ont été traitées par des épandages aériens de diverses préparations du virus de la polyédrose nucléaire (Virtuss) au moment où la plupart des larves se trouvaient au premier stade. Une première placette a reçu une dose de $2,5 \times 10^{11}$ corps d'inclusion polyédriques (CIP) par hectare sous forme d'une préparation huileuse émulsionnable, et une autre, la même dose, mais dans une préparation aqueuse contenant des mélasses. Les deux autres placettes ont reçu une préparation huileuse contenant $8,3 \times 10^{10}$ CIP/ha dans un cas et $1,6 \times 10^{10}$ CIP/ha dans l'autre. Les traitements ont été réalisés à l'aide d'un avion muni d'une rampe de pulvérisation étalonnée pour un débit de 9,4 L/ha. Quatre autres placettes ont été utilisées comme témoins.

Six semaines après les arrosages, la réduction de la population due au traitement (calculée suivant la formule modifiée d'Abbott) s'élevait à 65 % dans la placette ayant reçu la dose la plus faible et elle variait entre 87 et 95 % dans les trois autres placettes. L'infection virale, déterminée au microscope, a été maximale vers la 5e ou 6e semaine après l'arrosage, de 85–100 % des larves étant alors infectées. Le niveau d'infection naturelle dans les placettes témoins est demeuré faible. On a observé des taux d'émergence d'adultes variant entre 4 et 19 % chez les chrysalides récoltées dans les placettes traitées et entre 28 et 43 % chez celles des placettes témoins. La réduction de la densité

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des masses d'oeufs attribuable au traitement a été de 97 % dans une placette et de 99 % dans deux autres; elle n'a pas été déterminée dans la quatrième.

On estime qu'une dose de 8.3×10^{10} CIP/ha, soit le tiers de la dose déjà recommandée, est suffisante et que les deux préparations sont acceptables.

Introduction

The bionomics of Douglas-fir tussock moth, *Orgyia pseudotsugata* (McDunnough), in British Columbia and the western United States (U.S.A.) have been reviewed by Wickman and Beckwith (1978) and Shepherd *et al.* (1984*b*). Naturally occurring nuclear polyhedrosis virus (NPV) epizootics usually terminate Douglas-fir tussock moth outbreaks (Dahlsten and Thomas 1969; Mason and Luck 1978), but not before trees are severely defoliated or killed (Wickman 1978).

Dissemination of virus as a biocontrol agent was considered as early as 1962 in British Columbia (Morris 1963), but it was not until 1975 that large-scale aerial spray experiments were conducted in collaboration with U.S.D.A. Forest Service personnel in British Columbia (Stelzer *et al.* 1977; Shepherd 1980; Cunningham and Shepherd 1984). Two NPV morphotypes were tested: a unicapsid type with virus particles embedded singly in inclusion bodies and a multicapsid type with bundles of virus particles occluded. Subsequently, the multicapsid type was registered by the Environmental Protection Agency in the U.S.A. in 1976. The same virus, propagated in whitemarked tussock moth, *Orgyia leucostigma* (J.E. Smith), was granted a temporary registration in Canada in 1983 under the name Virtuss. This product contains lyophilized, virus-infected larvae ground to a fine powder.

Virtuss was applied both from the air and the ground in 1981 at the early phase of a Douglas-fir tussock moth outbreak in south-central British Columbia before the occurrence of a natural virus epizootic. From the air, a dosage of 2.2×10^{11} polyhedral inclusion bodies (PIB) per hectare in 11.3 L/ha was applied; from the ground, a dosage of 2.4×10^{10} PIB in a volume of 4.5 L was applied to each tree. All treatments prevented outbreaks (Shepherd *et al.* 1984*b*). Aqueous tank mixes with the addition of 25% (v/v) molasses were used in 1981; this mix has been widely used in previous tests in both Canada and the U.S.A. (Cunningham 1982). However, with the low relative humidity in the interior of British Columbia, spray deposits have often been poor.

In 1982, the second year of the Douglas-fir tussock moth outbreak at another location, Virtuss was again applied from the air, using two different tank mixes. In the water mix, the full dosage (2.5×10^{11} PIB per hectare) of the virus was used; in the oil mix, the virus was applied at the full dosage, as well as at two reduced dosages. The aim of these trials was 2-fold: (*a*) to compare an emulsifiable oil tank mix with an aqueous tank mix; and (*b*) to test reduced dosages of virus in the oil tank mix in an effort to reduce treatment costs. The impact of these treatments in the year of application, assessed by several different methods, is described.

Materials and Methods

Experimental plots. Four 10-ha plots containing Douglas-fir, *Pseudotsuga menziesii* var. *glauca* (Beissner) Franco, and a few scattered ponderosa pine, *Pinus ponderosa* Lawson, were selected for treatment near Veasy Lake, about 15 km northwest of Cache Creek, B.C., at elevations ranging from 700 to 900 m in the Kamloops Forest District. Four check plots (no treatment) were established in the same area (Fig. 1). Treatment plots were separated by a minimum buffer zone of 300 m and check plots were 300 m to 1 km away from the treated plots.

Treated plots were numbered T1, T2, T3, and T4 and matched to untreated check plots which had comparable insect population densities. Plot C4 was selected 3 days after the spray application because the pre-spray counts revealed that C1, C2, and C3 had much

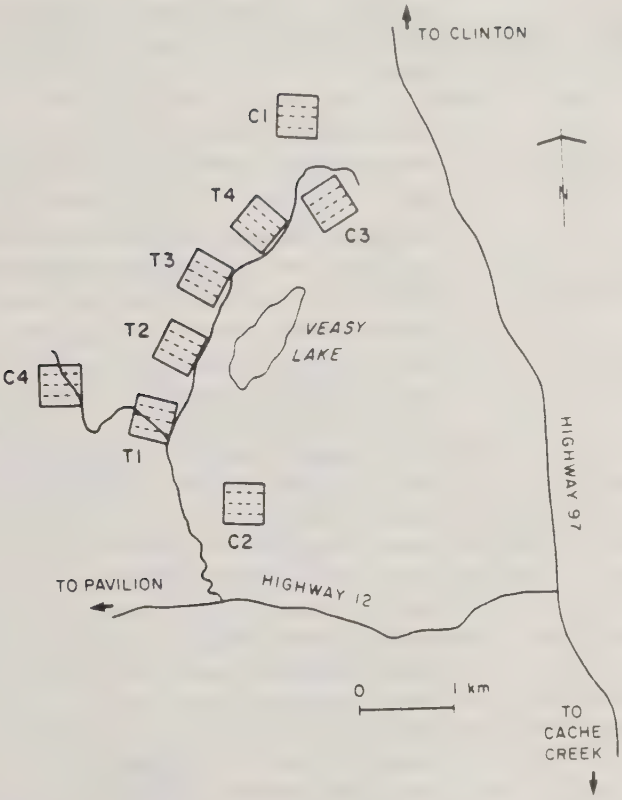

FIG. 1. Location of study plots for the experimental application of Virtuss on Douglas-fir tussock moth infested stands near Veasy Lake, Kamloops Forest District, B.C., 1982. Plots T1–T4 were treated and matching check plots were designated C1–C4. Broken lines through plots indicate lines of sample trees; spray aircraft flew at right angles to these lines.

higher population densities than spray plot T4 and a search was made for a plot with a comparable insect population density.

Spray application and monitoring deposit. Three dosages of Virtuss, 1.6×10^{10}, 8.3×10^{10}, and 2.5×10^{11} PIB per hectare, were tested in an emulsifiable oil carrier. The carrier was supplied by Abbott Laboratories and is the vehicle used to formulate their *Bacillus thuringiensis* Berliner variety *kurstaki* isolate HD-1 product called Dipel 88®. Virtuss was suspended in water and emulsifiable oil was added until the final ratio was one part of oil to three parts of water. A fourth plot was treated with 2.5×10^{11} PIB per hectare in an aqueous tank mix containing one part of animal-feed grade molasses to three parts of water. Rhodamine B dye at 0.04% was added to all tank mixes to monitor spray deposit.

Treatments were assigned randomly to the blocks. Timing of the spray application was determined by monitoring 50 Douglas-fir tussock moth egg masses per plot daily for larval hatch and dispersal. The spray was applied 1 week after 90% of the larvae had dispersed from these egg masses; the larvae were mainly in the first instar although a few second-instar larvae were present. A Cessna AgWagon was calibrated to deliver 9.4 L/ha through 42 Tee-Jets with 8005 nozzles mounted on the boom. Flight speed was 180 km/h at a height of 15 m above the tallest trees and the swath width was 30 m. Spraying was conducted at dawn when wind speed was about 2 km/h. The three treatments of Virtuss in emulsifiable oil were applied on 16 June, and the water and molasses tank mix was

applied on 17 June. Relative humidity on the ground was measured with a sling psychrometer. A rain gauge was used to measure precipitation for 1 week after application at the sites.

Spray deposit was monitored on Kromekote® cards held in wire holders about 50 cm above ground level placed about 10 m apart in openings in the forest canopy. Two lines of cards at right angles to the flight path were set 30 m from both ends of each treated plot. All cards were collected about 1 h after spraying and later analyzed for droplet density.

Egg-mass, larval, and pupal surveys. Fifteen Douglas-fir trees were selected as sample trees in each of three lines per plot giving a total of 45 sample trees per plot. There was about 110 m between lines and about 15 m between sample trees. None of the sample trees was closer than 50 m to a plot boundary. Sample trees were about 12 m tall and had ample foliage for weekly branch sampling. Egg-mass surveys (Shepherd *et al.* 1984*a*) were conducted in each plot in early spring, before eclosion and virus treatment, and again in late fall after oviposition was completed. The mean number of Douglas-fir tussock moth egg masses on three lower whole branches was recorded for each of the 45 sample trees. Pre-spray larval counts were made from two, 45-cm branch tips cut from the mid-crown of each sample tree in each plot: hence, counts were made from 90 branch samples per plot. Counts were made at weekly intervals until 6 weeks after spraying when pupation commenced. For each branch, foliated length, average foliated width, and number of live and dead larvae were recorded. The foliated area was calculated for each branch: the density of larvae for that area was converted to number of larvae per square metre and used to calculate standard deviation and standard errors. Sampling crews and equipment were assigned to either treated or check plots for the duration of the experiment to avoid contamination of the check plots with virus. Population reduction due to treatment was calculated using a modified Abbott's formula (Abbott 1925) described by Fleming and Retnakaran (1985). These calculations used mean numbers of live Douglas-fir tussock moth larvae derived by dividing the total number of larvae counted from the branch samples by the total foliated area (in square metres) of these branches. Approximately 1 week after pupation was first observed, cocoons were collected from all plots and reared to determine adult emergence and sex ratio.

Virus impact assessment. This was done by rearing larvae collected before the spray and by microscopic examination of larvae collected after the spray. Larvae, collected from the pre-spray population samples, were placed individually on artificial diet and reared until death or adult emergence. Dead larvae and pupae were examined microscopically to determine the cause of death. It was planned to collect 100–200 larvae per treated plot at weekly intervals commencing 2 weeks after spraying. However, after week 4, sample size dropped to as low as 60 in some treated plots due to virus-caused mortality and it was difficult to find living larvae; in T4 at week 7 only 20 were collected after intensive searching. The larvae were smeared on slides and examined microscopically for NPV. Larvae from check plots were examined for NPV 3, 5, 6, and 7 weeks after spraying.

Defoliation surveys. Defoliation due to Douglas-fir tussock moth larvae could not be estimated accurately because a low to moderate population of western spruce budworm, *Choristoneura occidentalis* Freeman, was also present in the plots.

Results

Spray deposit and meteorological conditions. At the time of spraying, wind speed was about 2 km/h, temperatures ranged from 11.5 to 21°C, and relative humidity from 46 to 63% (Table 1). Spray deposit was observed on all the cards. Best coverage was obtained with the aqueous tank mix containing molasses, with 27.3 droplets per square centimetre. Coverage on the plots treated with the emulsifiable oil tank mix ranged from 4.4 to 12.0 droplets per square centimetre, which is light considering that the emitted volume was

Table 1. Dosages, meteorological conditions during spray application, and spray deposits of Virtuss applied against Douglas-fir tussock moth at Veasy Lake, Kamloops Forest District, B.C., 1982

Treatment	Tank mix	Dosage (PIB/ha)	Temperature (°C)	Relative humidity (%)	Wind speed (km/h)	Droplet cm^{2} ($\bar{x} \pm$ SD)
T1*	Oil	1.6×10^{10}	13.0	59	2	4.4 ± 2.5
T2	Oil	8.3×10^{10}	16.0	63	2	12.0 ± 9.8
T3	Oil	2.5×10^{11}	21.0	46	2	9.7 ± 5.5
T4	Aqueous	2.5×10^{11}	11.5	52	1	27.3 ± 9.0

*T, treatment.

9.4 L/ha (Table 1). No precipitation was recorded for 1 week after spray application; therefore no leaching of the virus from the needles occurred.

Egg-mass, larval, and pupal surveys. Spring egg-mass densities (Fig. 2) were greater than 0.7 per three lower branches on plots T1, T2, T3, and C1, C2, C3; noticeable defoliation would be expected if these plots were left untreated (Shepherd *et al.* 1984*a*). Plot T4, with a value of 0.52, was not expected to show noticeable defoliation and no survey was conducted on plot C4 as it was selected after eclosion and larval dispersal.

Egg-mass surveys conducted in the fall of 1982 (Fig. 2) showed that egg-mass densities in all treated plots were reduced from their spring outbreak values to endemic levels of 0.089 or less. In plots T3 and T4, which received the highest dosages of NPV, egg-mass density was 0.02. When Abbott's formula was applied to correct for natural mortality, reduction in egg-mass density attributed to treatment was 97% in plot T1 and 99% in plots T2 and T3. Egg-mass reduction in plot T4 could not be calculated because no spring egg-mass survey was conducted on its paired check (plot C4). The pre-spray population densities of Douglas-fir tussock moth larvae and the count taken 6 weeks after spraying are shown in Table 2, along with the population reductions. Applications of Virtuss in an oil tank mix gave population reductions of 65–95%; this suggests a direct

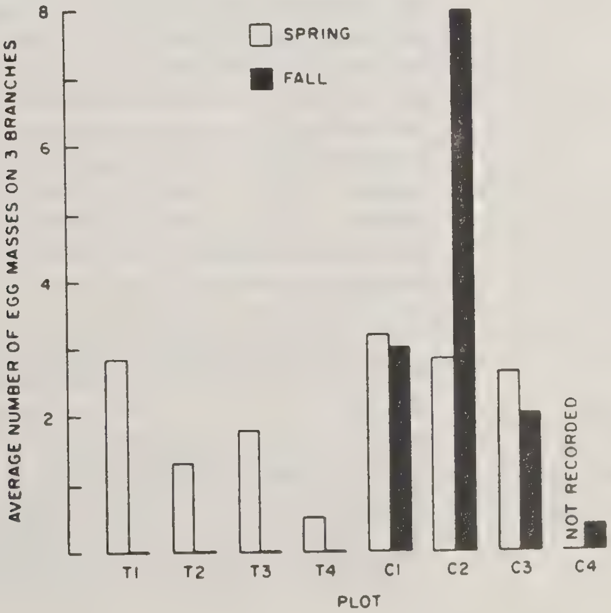

FIG. 2. Spring and fall egg-mass densities in treated and check plots at Veasy Lake, Kamloops Forest District, B.C., 1982. Values for fall collections were 0.089, 0.04, 0.02, and 0.02 for T1, T2, T3, and T4, respectively.

Table 2. Population densities of Douglas-fir tussock moth larvae in plots treated with Virtuss and in matching check plots at Veasy Lake, Kamloops Forest District, B.C., 1982

Plot No.	Treatment (PIB*/ha)	Tank mix	Larvae per m² foliage ($\bar{x} \pm SE$) Pre-spray	6 weeks post-spray	Population reduction due to treatment† (%)
T1‡	1.6×10^{10}	Oil	182.8 ± 12.6	6.7 ± 1.8	65
C1‡	Check	—	197.5 ± 18.0	20.5 ± 2.9	—
T2	8.3×10^{10}	Oil	145.8 ± 12.2	2.8 ± 0.7	91
C2	Check	—	136.9 ± 9.4	28.7 ± 2.8	—
T3	2.5×10^{11}	Oil	302.0 ± 28.7	1.0 ± 0.4	95
C3	Check	—	360.6 ± 34.6	24.1 ± 4.6	—
T4	2.5×10^{11}	Aqueous	41.8 ± 5.3	2.0 ± 0.6	87
C4	Check	—	81.2 ± 16.5	28.9 ± 4.3	—

*PIB, polyhedral inclusion bodies.
†Calculated using a modified Abbott's formula (Fleming and Retnakaran 1985).
‡T, treatment; C, check.

relationship to dosage. The 2.5×10^{11} PIB per hectare dosage in the oil tank mix gave 95% population reduction, one-third of this dosage 91%, and one-sixteenth 65%. The 2.5×10^{11} PIB per hectare dosage in the aqueous tank mix with molasses reduced the population by 87%. The pattern of changes in larval population densities and NPV infection rates between 2 and 7 weeks after spraying are shown in Figure 3. Emergence from field-collected cocoons from treated plots T1, T2, T3, and T4 was 18, 4, 10, and 20%, respectively; those from check plots C1, C2, C3, and C4 showed 43, 28, 33, and 35% adult emergence, respectively (Table 4). The reduction in adult emergence due to NPV treatment, using Abbott's formula, ranged from 44 to 87%. The sex ratios of the emerging adults were inconsistent.

Virus impact assessment. From 73 to 89% of the larvae collected before spraying from the eight plots were successfully reared to adults (Table 3). Microscopic examination of larvae that died during rearing showed a low incidence of naturally occurring virus except in check plot C4 where 9.7% died from NPV. However, subsequent samples from this plot showed a lower incidence of NPV infection (Fig. 3), indicating that this sample, which was collected post-spray, may have been contaminated during handling. Microscopic examination of the larvae showed that the incidence of NPV infection in the treated plots reached a peak of about 85–100% of the larvae at 5–6 weeks after spraying (Fig. 3). In contrast, NPV in untreated check plots at 5 weeks after spraying only reached infection levels ranging from 0.7 to 10.3%. In the final sample taken 7 weeks after spraying, the highest infection level was 43.4% in C3. This was attributed to naturally occurring NPV. In the other check plots, infection ranged from 1.4 to 23.4%.

Percentage infection and development of an epizootic among the larvae in the four treated plots was directly related to dosage with the exception of plot T4. Although this plot received 2.5×10^{11} PIB per hectare, in the aqueous formulation, the epizootic developed slower than in the other three plots. This slower development was probably due to a lower initial Douglas-fir tussock moth population density. However, by 5 weeks after the spray, percentage infection in plot T4 was higher (97.7%) than in plots T1 and T2 (68.5 and 84.5%, respectively) receiving the reduced dosages. The results in plot T4 show that even at relatively low population levels (41.8 larvae per square metre) it is possible to cause a viral epizootic by application of Virtuss.

Defoliation survey. Although heavy defoliation was observed in most plots, a formal evaluation was not possible because of the light to moderate western spruce budworm population in some of the plots. However, Douglas-fir tussock moth larvae continued to

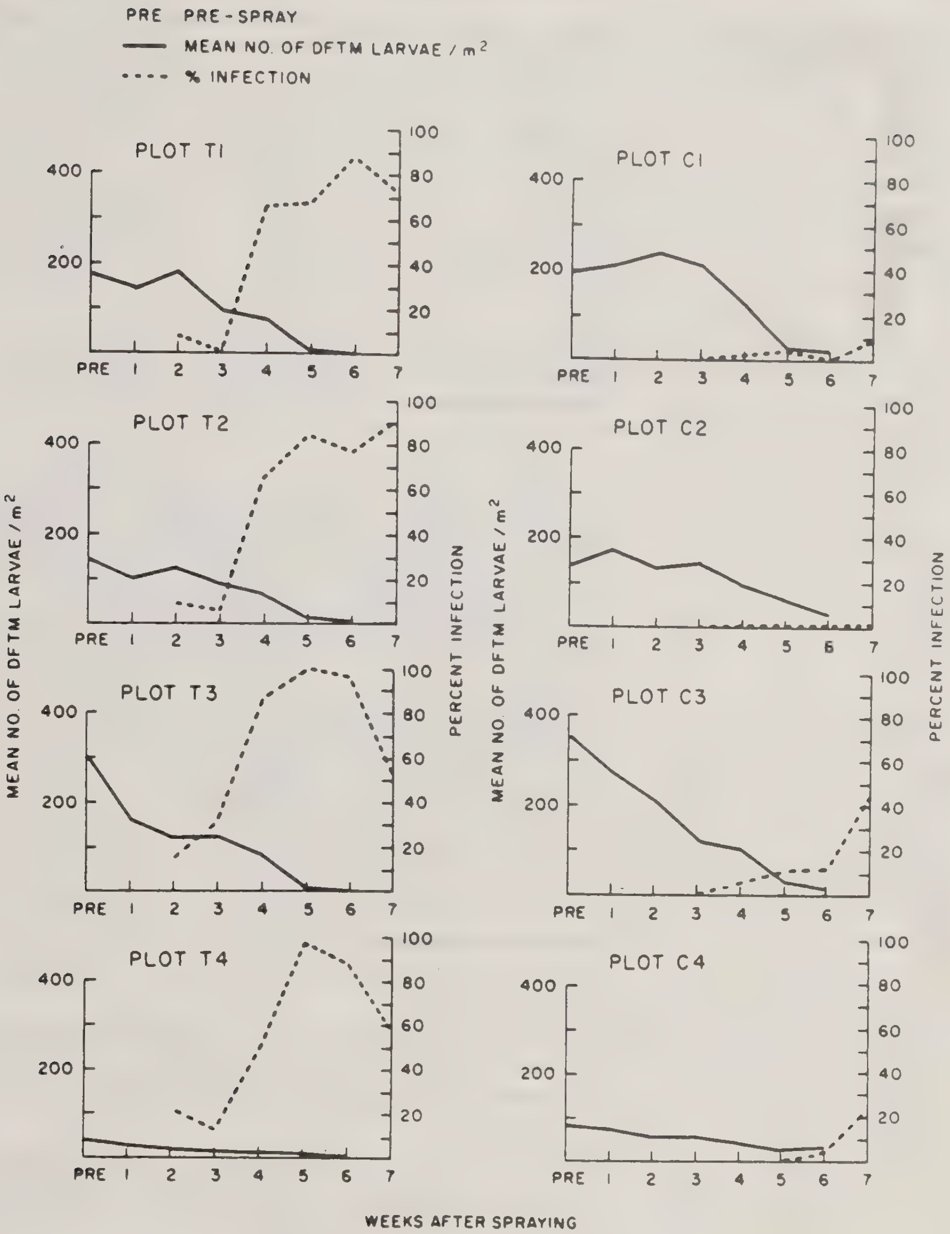

FIG. 3. Douglas-fir tussock moth larval density per square metre of foliage and percentage NPV infection of larvae following application of Virtuss on four treated plots compared with four matching untreated check plots.

feed for several weeks after the spray application. Except on plot T4, the current year's foliage was destroyed on many trees as well as most of the older foliage, with upper crowns particularly heavily defoliated. Plot T4 had an egg-mass density in the spring slightly below the outbreak threshold, whereas plots T1, T2, and T3 were well above this threshold. The apparent foliage protection in plot T4 was probably due to the low Douglas-fir tussock moth population and not the Virtuss treatment.

Table 3. Mortality of individually reared larvae collected before spraying from plots at Veasy Lake, Kamloops Forest District, B.C., 1982

Treatment	Total no. reared	% adult emergence	% Mortality by	
			NPV	Other causes
T1*	167	73.1	0.6	26.3
T2	172	83.1	2.3	14.5
T3	161	80.8	0	19.2
T4	168	82.7	0.6	16.7
C1*	175	89.1	0.6	10.3
C2	180	86.1	1.7	12.2
C3	170	87.1	0.6	12.4
C4	155	78.1	9.7	12.3

*T, treatment (for detail see text or Table 1); C, check.

Discussion

The amount of deposits recorded on Kromekote cards did not reflect the subsequent impact of Virtuss on the Douglas-fir tussock moth population. Two probable reasons for this are that the amount of spray reaching the foliage is not indicated accurately by the amount of spray on the cards and that secondary infection occurred among the larvae. Weekly microscopic examination of samples of larvae revealed NPV infection in about 10–30% of the larvae 2–3 weeks after spraying. When these larvae died, they ruptured and released massive quantities of PIBs onto the foliage. Secondary infection probably resulted from these virus foci and caused an epizootic that decimated the Douglas-fir tussock moth population. Douglas-fir tussock moth is an ideal candidate for control using a virus because it spends about 8 weeks in the larval stage. This allows ample time for the development of an epizootic if the virus is applied when larvae are in the early instars. However, if foliage protection is the principal objective, this may not be an acceptable strategy where high larval populations will completely defoliate trees before an epizootic can develop. To protect foliage, Virtuss should be applied before the Douglas-fir tussock moth population reaches outbreak levels. In most cases this would require treatment the year before defoliation can be observed; a population detection and monitoring system would be essential.

The emulsifiable oil tank mix and the aqueous tank mix containing molasses both gave acceptable results at a dosage of 2.5×10^{11} PIB per hectare. This dosage, originally recommended by the U.S.D.A. Forest Service, is also the dosage on the Virtuss label.

Table 4. Emergence and sex of adult Douglas-fir tussock moth from field-collected pupae from Virtuss-treated plots and check plots, Veasy Lake, Kamloops Forest District, B.C., 1982

Treatment	Number* of pupae reared	Ratio (males:females)	Adult emergence (%)	Emergence reduction† (%)
T1‡	107	5.2:1	17.8	58
C1‡	219	2.1:1	42.9	—
T2	108	1:1	3.7	87
C2	181	1:2.2	28.2	—
T3	105	1:2.3	9.5	71
C3	117	1:1.4	33.3	—
T4	52	1.5:1	19.5	44
C4	265	1.4:1	35.0	—

*Collection included some larvae that pupated shortly after collection.
†Attributed to treatment and calculated using a modified Abbott's formula.
‡T, treatment; C, check.

Present production cost of this dosage in Canada (at Sault Ste. Marie, Ont.) is about \$50 (Canadian) per hectare. Virtuss at 8.3×10^{10} PIB per hectare in the emulsifiable oil tank mix (T2) gave a similar degree of control as the recommended dosage. If this dosage gives consistently good results, cost of virus material would be reduced to \$17 per hectare. The lowest dosage, formulated and used in the emulsifiable oil tank mix, 1.6×10^{10} PIB per hectare (T1), had less impact than the other treatments when population reduction of both larvae and pupae was considered, but it was still markedly different from the untreated checks and reduction in egg-mass density was impressive at 97%. At this concentration, the production cost would be only \$3.20 per hectare, but because experience with Virtuss is limited, we cannot recommend it for operational use at this dosage.

The adult sex ratio is usually 1:1 in Douglas-fir tussock moth (Wickman and Beckwith 1978), but changes of sex ratio in favor of males have been noted following NPV applications (Cunningham 1982). In many Lepidoptera and Hymenoptera, females pupate later than males giving females more time to ingest virus, become infected, and die. With six larval instars in the female and five in the male, this was expected to be evident with Douglas-fir tussock moth. However, a significant change in sex ratio, 5.2 males to 1 female, was found only in plot T1 which received the lowest dosage. There is an interesting discrepancy between adult emergence from the pre-spray larval samples from all eight plots reared in the laboratory, where emergence figures ranged from 73.1 to 89.1%, and adult emergence from cocoons collected in the four check plots, where figures ranged from 28.2 to 42.9%. Perhaps natural control factors, including starvation, reduced pupal viability in the field.

Fall egg-mass densities can be one of the most meaningful measurements of efficacy because one can use these values to predict population densities in the following year (Shepherd *et al.* 1984*a*). This survey showed high Douglas-fir tussock moth populations would occur on the four untreated check plots and low or endemic populations on all treated plots. Although plot T1 had the highest egg-mass density of all treated plots at 0.089 per three lower branches, we predict that this density will be below the damage threshold level of Douglas-fir tussock moth, based on the findings of Shepherd *et al.* (1984*a*). Hence, even the lowest dosage may have provided sufficient control to return the population to an endemic level.

Surveys were conducted in 1983, 1984, and 1985 on all the treated and check plots to determine virus spread, virus carryover, fate of the residual Douglas-fir tussock moth population on the treated plots, incidence of naturally occurring NPV in the check plots, and effect of the Virtuss treatment in terms of tree damage and mortality (Otvos *et al.* 1987). The latest outbreak of Douglas-fir tussock moth in British Columbia collapsed in 1984 and another outbreak is not expected until 1989 at the earliest. When it occurs, we intend to treat blocks (400 ha or larger) with Virtuss at 2.5×10^{11} and 8.3×10^{10} PIB per hectare to determine if the lower dosage found effective here is equally effective on an operational scale.

Acknowledgments

We thank the British Columbia Ministry of Forests (B.C.M.F.) who financed the virus application and provided field crews for the asssessment. We also thank R.S. Chorney, Dave Piggin, and his B.C.M.F. staff for providing laboratory space at the Ashcroft Field Office; C.S. Simmons, Pacific Forestry Centre (P.F.C.), for his help with data analysis; and Martin Talmon de l'Armee (P.F.C.), John McPhee, and Betty E. Cunningham, Forest Pest Management Institute, for excellent technical assistance. We greatly appreciate the thoughtful review of this manuscript by M.J. Stelzer, U.S.D.A. Forest Service, Corvallis, Oregon, and R.F. Shepherd, M.A. Hulme, J. Sutherland, and S. Glover, Scientific Editor (P.F.C.). John Wiens (P.F.C.) prepared the figures.

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(Date received: 1986 11 12; date revision received: 1987 04 03; date accepted: 1987 04 06)

REGION 5

As far as defoliators were concerned things were quite in the region with no DFTM or budworm problems. Our time was spent working on drought/bark beetle problems.

The only item of interest to this Committe is that in cooperation with the WO we have sumitted new toxicology data to California Dept. of Food and Agriculture to support the registration of TM-Biocontrol-1. The studies were:

- Acute Dermal
- Chomosome Aberration
- Primary Eye Irritaition
- Acute Pulmonary Toxicity
- Acute Oral
- Dermal Irritation
- Intraperitoneal Infectivity

This information was also submitted to EPA to support the national registration. We recommend that other regions submit this information to your states if such data is need to continue state registrations.

11/6/90
Julie Weatherby

Western Defoliator Report for Region 4

Gypsy Moth Eradication Project - Wasatch Front, Utah

Site: 20,000 AC in Salt Lake, Utah and Davis Counties.

Applications: 3 applications of Foray 48B, NEAT at 64 oz. per AC

Application Aircraft: 2 Jet Rangers 206 B3, 1 Hiller Soloy

Atomizers: Beecomists

Results: Significant population reductions have occurred in most areas within the spray blocks. The project successfully reduced the population to non-detectable levels in many area. These areas will be excluded from the spray project planned for 1991.

Plans for 1991 Project: The project objective will be to eradicate the population from the area. The project area will be approximately 22,000 - 25,000 Ac. Approximately 3,000 acres will be on State and Private Lands. The remaining acreage will be on Forest Service Lands.

Douglas-fir Tussock Moth Outbreak - Southern Idaho

Site: Approximately 35,000 AC of moderate to heavy defoliation has been detected on the Boise National Forest. Several other smaller areas of defoliation haven been detected on the Sawtooth NF, the Payette NF, State lands east of Bellivue, and on BLM lands in the Owyhee Mtns.

Pheromone trap catches for 1990 are extremely high across southern Idaho except for the trap sites on the Salmon NF.

Douglas-fir Tussock Moth Outbreak - Wasatch-Cache NF

Site: Approximately 2,000 AC of heavy defoliation of subalpine fir has been detected in upper Blacksmith Canyon. Little is know about populations in surrounding stands.

Western Spruce Budworm Defoliation - Salmon, Challis, and Payette NFs

Site: Approximately 41,800 AC of light to heavy defoliation has been detected on the Salmon NF, 800 AC of light defoliation on the Challis NF, and 9,200 AC of light defoliation on the Payette NF.

Ponderosa Pine Needleminer - Sawtooth NF

Site: Approximately 600 Ac of defoliation caused by the ponderosa pine needleminer has been detected on the Sawtooth NF in the Marsh Creek drainage.

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Region 6 Report for the National Steering Committee on the Aerial Application for Western Coniferous Defoliators

1990 WESTERN SPRUCE BUDWORM SUPPRESSION PROJECT, YAKIMA INDIAN RESERVATION, WA

LOCATION: Yakima Indian Reservation, Washington

INSECTICIDE: Thuricide 48LV applied undiluted at a rate of 16 BIU's in 42.7 oz. per acre.

APPLICATION: Primary Applicator: Aero Tech, Inc., Bovina, Texas
Subcontractor: P.J. Helicopters, Red Bluff, CA
Fixed wing: 3 Air Tractors
Helicopters: 2 UH1B-20L
Observation Helicopters: 2 Bell 200
2 Hughes 500

ACRES TREATED: 70,827

COST: $15.35 PER ACRE

DISCUSSION: The Yakima Project was an operational project that was carried out on the Yakima Indian Reservation. Treatment began on June 20 and was completed on June 29. The terrain was characterized as gentle and rolling, with a few deep canyons. The project consisted of 3 treatment areas: Signal Peak, Simcoe West, and Simcoe East. Early larval densities qualified the units with 24 to 29 larvae per 45 cm. branch. Post-spray population densities averaged 1.7, 5.0, and 2.4 larvae per three 45 cm. mid-crown branch tips.

STATUS OF OTHER ACTIVITIES IN R-6

- A second year of follow-up sampling was done in the Meacham Pilot Project area. This area was treated in 1988. Although results for the sampling ar not yeat available, larval populations appear to have increased substantually. This area is being considered in a western spruce budworm environmental analysis being conducted by the Wallowa-Whitman NF for 1991.

- In cooperation with Roy Beckwith, PNW Station, a formulation of a carrier produced by ESPRO, was tested for TM Biocontrol-1. It appears to handle fairly well in the lab. The next step will be to test it in an aircraft system.

- Douglas-fir Tussock moth populations appear are increasing, especially in the vicinity of the Pine RD on the Wallowa-Whitman NF. Pheromone trapping, lower crown beating for larvae, and pupae/egg mass searches have been conducted in this area. Results are not available but indications are that there will be significant defoliation in 1991. The Forest is conducting an environmental analysis of 11 units on a total of 300,000 acres. There are indications from other areas within the Blue Mtns. that populations are also beginning to increase in those areas.

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[illegible] Cooperative [illegible]

[illegible] SPRUCE BUDWORM [illegible]

[illegible]ATION: [illegible] Indian Reservation, Washington [illegible]

[illegible]UCTION: Thuricide [illegible]

[illegible]

[illegible] TREATED: 70,000

[illegible] $15.75 PER ACRE

[illegible]USSION: The Yakima [illegible] the Yakima Indian Reservation. [illegible]

[illegible] OF OTHER ACTIVITIES IN [illegible]

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